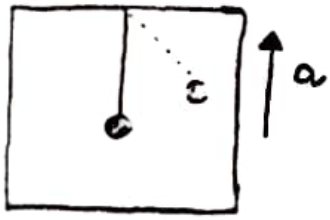
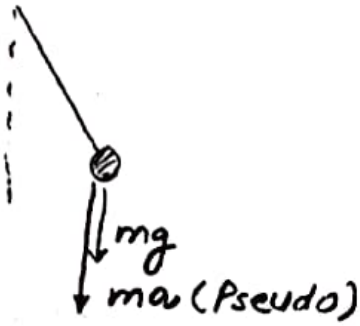
TIPS & TRICKS

• SIMPLE PENDULUM IN LIFT {ACCELERATING PENDULUM IN LIFT}

1>



If we look at the fbd of mass, we will need to find the total force on mass {including pseudo force}



$F = mg + ma$

$mg_{eff} = mg + ma$

$g_{eff} = g + a$

2nd way:

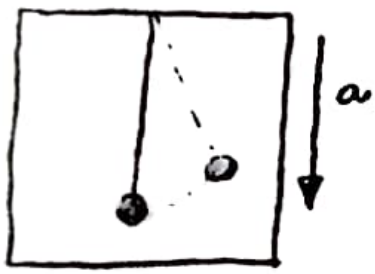
Take $g_{eff} = |\vec{g} - \vec{a}|$ Now if ↓ is taken negative

so, $\vec{g} = -g$ & $\vec{a}_P = +a$

so, $g_{eff} = |-g - a| = g + a$

So, $T = 2\pi\sqrt{\frac{l}{g_{eff}}} = 2\pi\sqrt{\frac{l}{g+a}}$

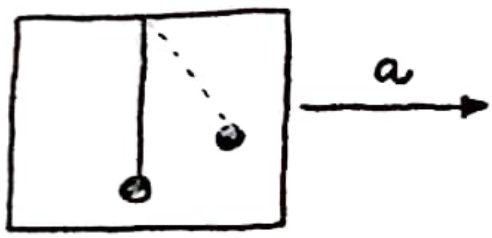
2>



$T = 2\pi\sqrt{\frac{l}{g-a}}$

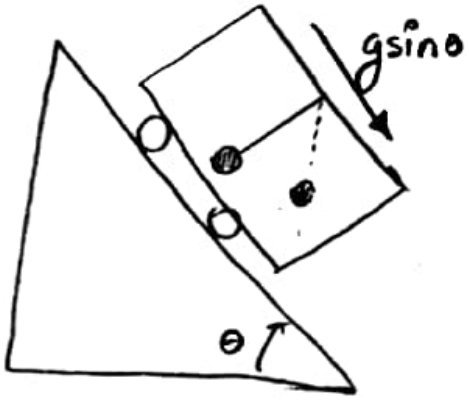
In case of free fall $a = g$, $T = \infty$

3>



$g_{eff} = \sqrt{g^2 + a^2}$

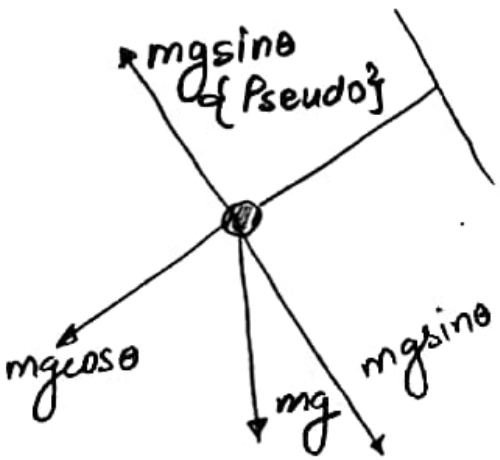
so, $T = 2\pi\sqrt{\frac{l}{\sqrt{g^2+a^2}}}$



$g_{eff} = g\cos\theta$

$T = 2\pi\sqrt{\frac{l}{g\cos\theta}}$ { SOMEWHAT TRICKY }

TAKING FBD OF MASS { INCLUDING PSEUDO FORCE due to $g\sin\theta$ }



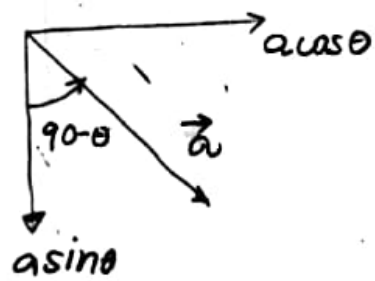
Total $g_{eff} = g\cos\theta$

2nd way

$g_{eff} = |\vec{g} - \vec{a}|$

here $\vec{g} = -g\hat{j}$

NOW $\vec{a} = a\cos\theta\,\hat{i} - a\sin\theta\,\hat{j}$



SO, NOW

$g_{eff} = |-g\hat{j} - a\cos\theta\,\hat{i} + a\sin\theta\,\hat{j}|$

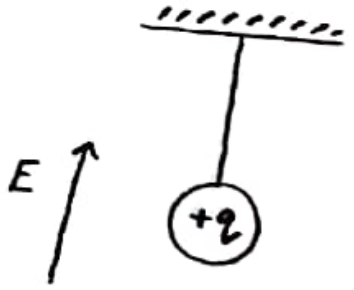
$= \sqrt{a^2\cos^2\theta + a^2\sin^2\theta + g^2 - 2ag\sin\theta}$

$= \sqrt{a^2 + g^2 - 2ag\sin\theta}$ as $\boxed{a = g\sin\theta}$

$= \sqrt{g^2\sin^2\theta + g^2 - 2g^2\sin^2\theta}$

$= \sqrt{g^2 - g^2\sin^2\theta} = g\cos\theta$

<5>



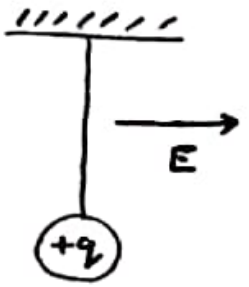
so,

$F = mg - qE$

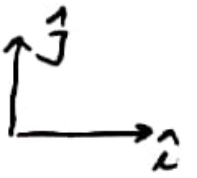
$g_{eff} = g - \frac{qE}{m}$

$$T = 2\pi\sqrt{\frac{l}{g - \frac{qE}{m}}}$$

<6>



Using $g_{eff} = |\vec{g} - \vec{a}|$



$\vec{g} = g(-\hat{j})$ $\quad \vec{a} = \frac{qE}{m}\hat{i}$

so, $g_{eff} = \sqrt{g^2 + \left(\frac{qE}{m}\right)^2}$

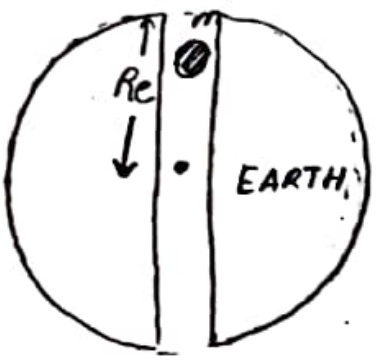
so, $$T = 2\pi\sqrt{\frac{l}{\sqrt{g^2 + \frac{q^2E^2}{m^2}}}}$$

* SOME SPECIAL CASES

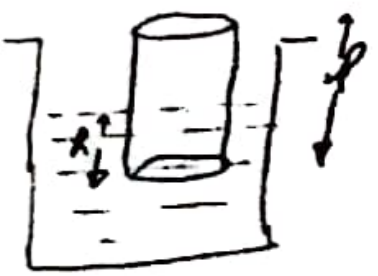
* Tunnelling the Earth

$$T = 2\pi\sqrt{\frac{R_e}{g}} = 84.6 \text{ min}$$

Amplitude $\leq R_e$



* Oscillation of Floating Cylinder

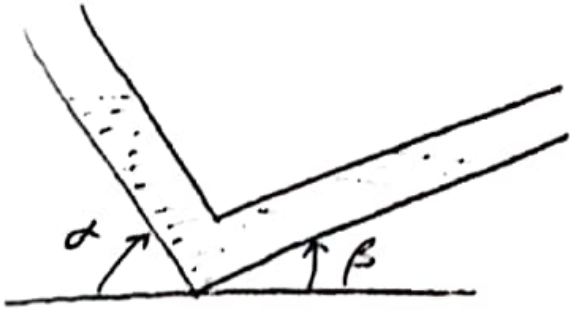


$\sigma \equiv$ density of cylinder

$\rho \equiv$ density of fluid ($\sigma > \rho$)

$$T = 2\pi\sqrt{\frac{\sigma L}{\rho g}} = 2\pi\sqrt{\frac{h}{g}}$$

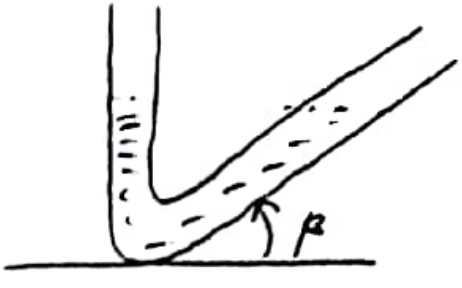
* Oscillation of Liquid in a Tube



$$T = 2\pi\sqrt{\frac{l}{g(\sin\alpha + \sin\beta)}}$$

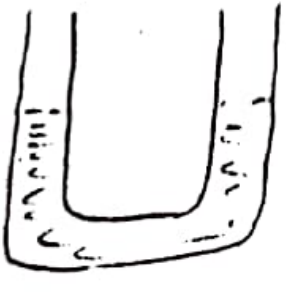
l = Total length of liquid column.

1> when $\alpha = 90^\circ$



$$T = 2\pi\sqrt{\frac{l}{g\sin\beta + g}}$$

=> when $\alpha = \beta = 90^\circ$



$$T = 2\pi\sqrt{\frac{l}{2g}}$$