Newtonian Mechanics is not general. Fails...

1) Small dimensions

$\longrightarrow$ Quantum Mechanics

2) Speeds close to $c$

$\longrightarrow$ Special Relativity

3) Strong gravity

$\longrightarrow$ General Relativity

Quantum Mechanics + Special Relativity $\}$ Quantum Field Theory

Quantum Field Theory + General Relativity $\}$ Theory of Everything

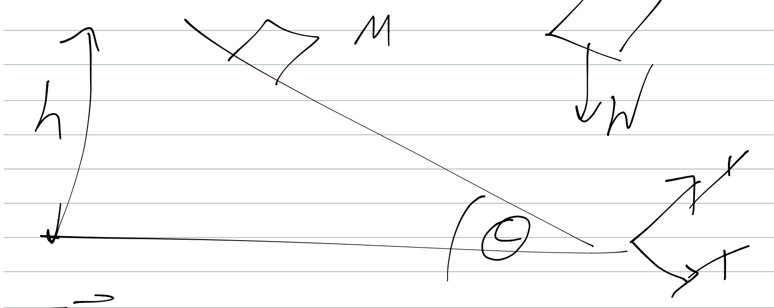
Schrödinger Equation

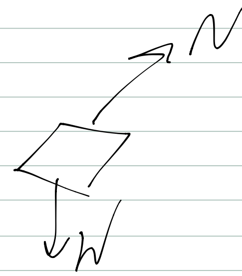
$$\left[\frac{-\hbar^2}{2m}\nabla^2 + V_{(x)}\right]\psi_{(x,t)} = \underbrace{i\hbar\frac{\partial}{\partial t}}_{E}\psi_{(x,t)}$$

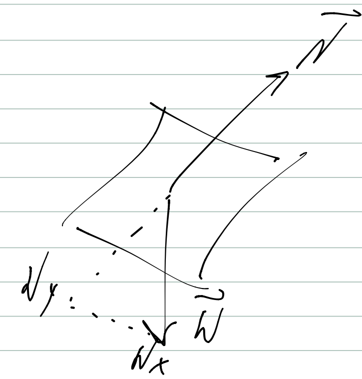
$$\frac{p^2}{2m} + V = E$$

$$\frac{\hbar}{i}\nabla$$

$$\hat{p}_{op}$$




$$\Sigma\vec{F} = m\vec{a}$$

$$\Sigma F_x = ma_x$$

$$ma_x = W\sin\theta$$

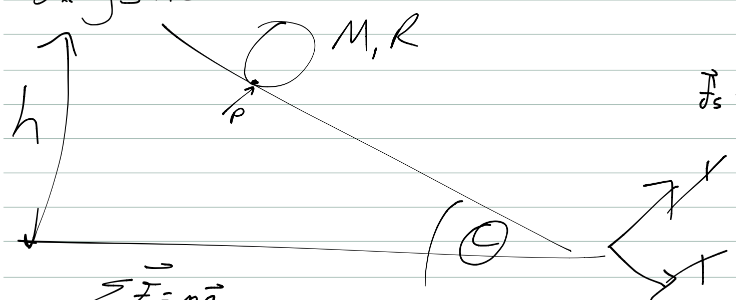
$$\cancel{m}a_x = \cancel{m}g\sin\theta$$

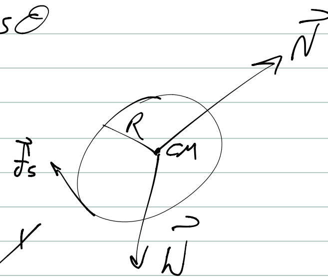
$$a_x = g\sin\theta$$

$$\Sigma F_y = m\overset{0}{a_y} = 0$$

$$N - W\cos\theta = 0$$

$$N = W\cos\theta = mg\cos\theta$$




$$\Sigma\vec{F} = m\vec{a}$$

$$\Sigma F_y = m\overset{0}{a_y}$$

$$N - mg\cos\theta + 0 = 0$$

$$N = mg\cos\theta$$

$$\Sigma F_x = ma_x$$

$$0 + mg\sin\theta - f_s = ma_x$$

$$\Sigma\tau = I\alpha$$

Torque = Moment of Inertia · Angular Acceleration

axis: 1) any point that does not accelerate eg $P$

2) center of mass, even if it accelerates

$\Sigma\tau_P$, knock out $\vec{N}, \vec{f_s}$

$\Sigma\tau_{cm}$, knock out $\vec{N}, \vec{W}$

$\Sigma \tau_{cm} = I_{cm}\alpha \qquad \alpha = \frac{a}{R}$

$f_s R = \frac{1}{2}MR^2\left(\frac{a_x}{R}\right)$

$f_s = \frac{1}{2}Ma_x$

Remember $Mg\sin\theta - f_s = Ma_x$

$\cancel{M}g\sin\theta - \frac{1}{2}\cancel{M}a_x = \cancel{M}a_x$

$g\sin\theta = \frac{3}{2}a_x$

$a_x = \frac{2}{3}g\sin\theta$

$v = \int a\,dt = \frac{2}{3}g\sin\theta t + \underset{v_0}{\text{constant}}$

$x = \int v_x(t)\,dt = \int \frac{2}{3}g\sin\theta t\,dt$

$= \frac{2}{3}g\sin\theta t^2 + v_0 t + \underset{x_0}{\text{constant}'}$

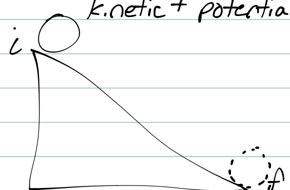
Again with Energy Conservation

Total Mechanical Energy

$E = K + U$

kinetic + potential

Work $= \int \vec{F}\cdot d\vec{s}$



$E_i = E_f \Rightarrow \boxed{K_i + U_i = K_f + U_f}$

$(K_f - K_i) + (U_f - U_i) = 0$

$\Delta K + \Delta U = 0$

$\Delta E = 0 \qquad \omega = \frac{v}{R}$

$0 + Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2 + 0$

$\cancel{M}gh = \frac{1}{2}\cancel{M}v^2 + \frac{1}{2}\left(\frac{1}{2}\cancel{M}R^2\right)\left(\frac{v}{R}\right)^2$

$= \frac{3}{4}\cancel{M}v^2$

$v = \sqrt{\frac{4gh}{3}}$