4)

$$mg\sin\theta = k\alpha\left(1 - \frac{L}{\sqrt{x^2+a^2}}\right)$$

To reduce to form:

$$1 - \frac{h}{u} = \frac{R}{\sqrt{1+u^2}}$$

$$\Rightarrow \quad 1 - \frac{mg\sin\theta}{k}\left(\frac{1}{x}\right) = \frac{L}{a\sqrt{1+\left(\frac{x}{a}\right)^2}}$$

$$\Rightarrow \quad 1 - \frac{mg\sin\theta}{ak}\left(\frac{a}{x}\right) = \frac{(L/a)}{\sqrt{1+\left(\frac{x}{a}\right)^2}}$$

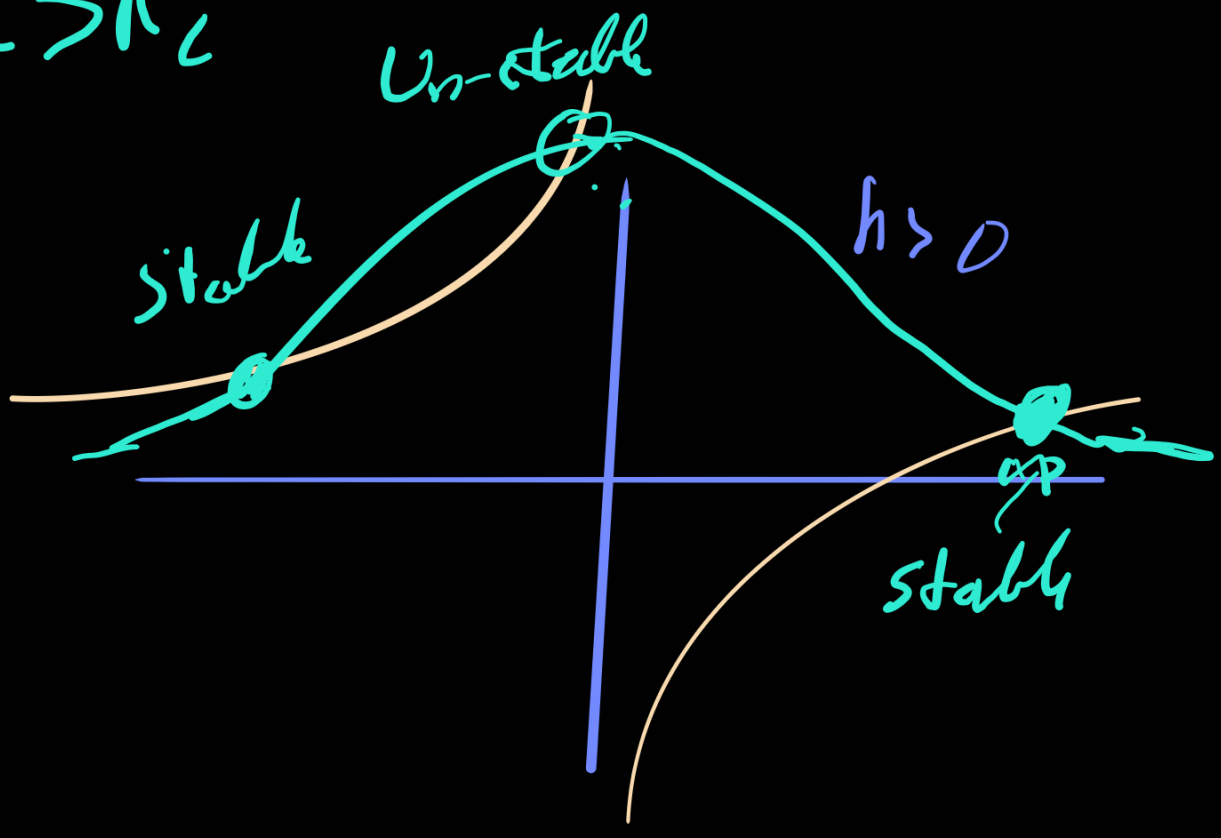
Let $\frac{x}{a} = v$, $\frac{mg\sin\theta}{ak} = h$, $\frac{L}{a} = R$

$$\Rightarrow 1 - \frac{h}{U} = \frac{R}{\sqrt{1+U^2}}$$

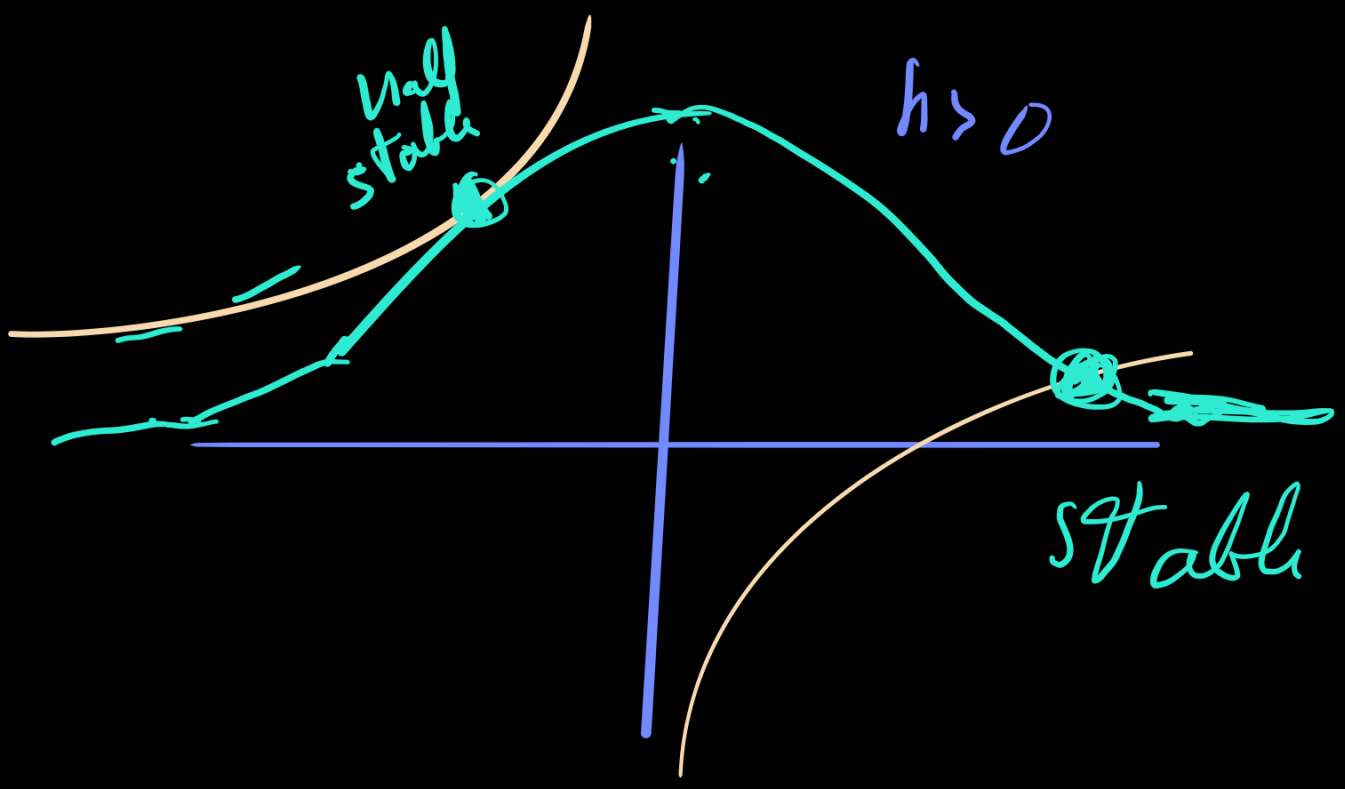
b)

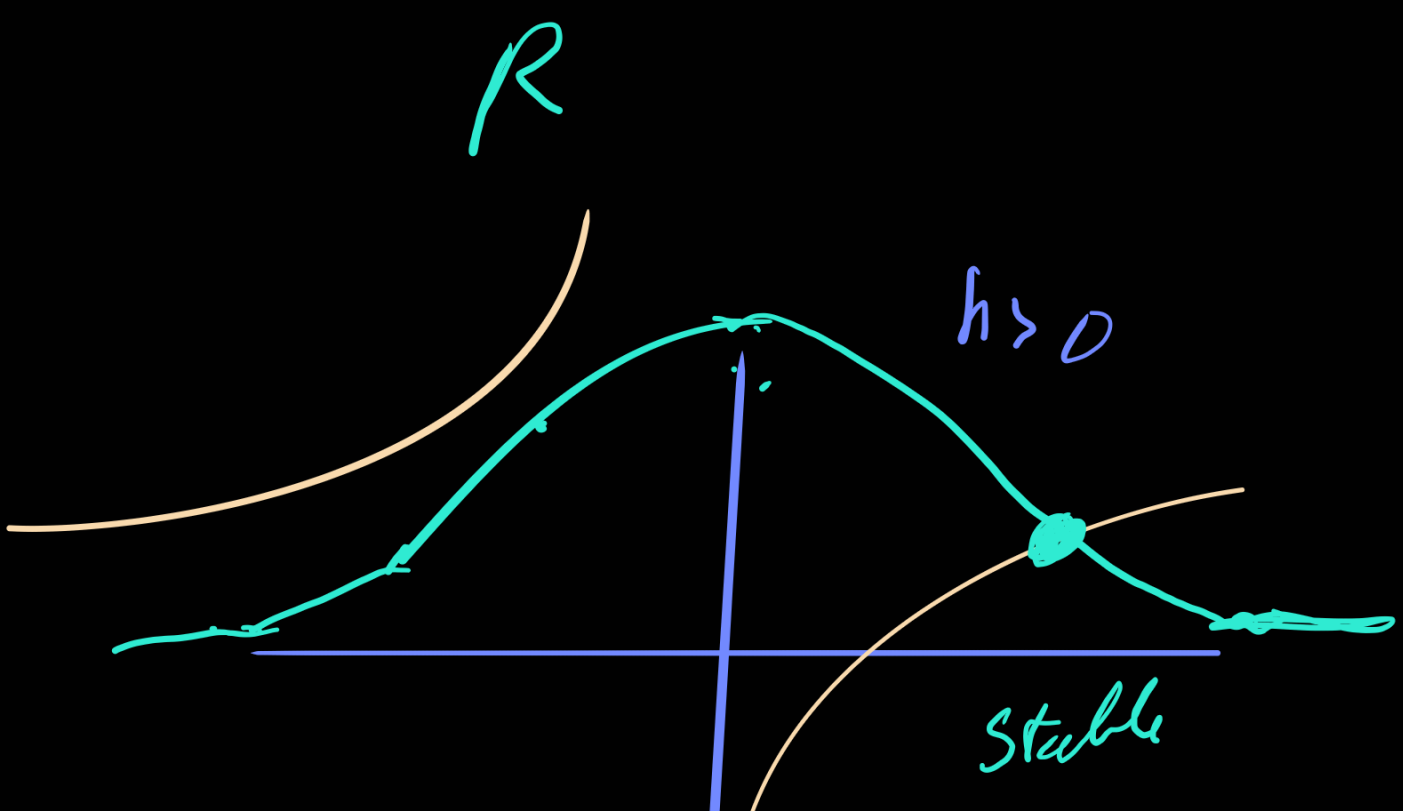
Graph of $1 - \frac{h}{U}$ vs $\frac{R}{\sqrt{1+U^2}}$

$R > R_c$



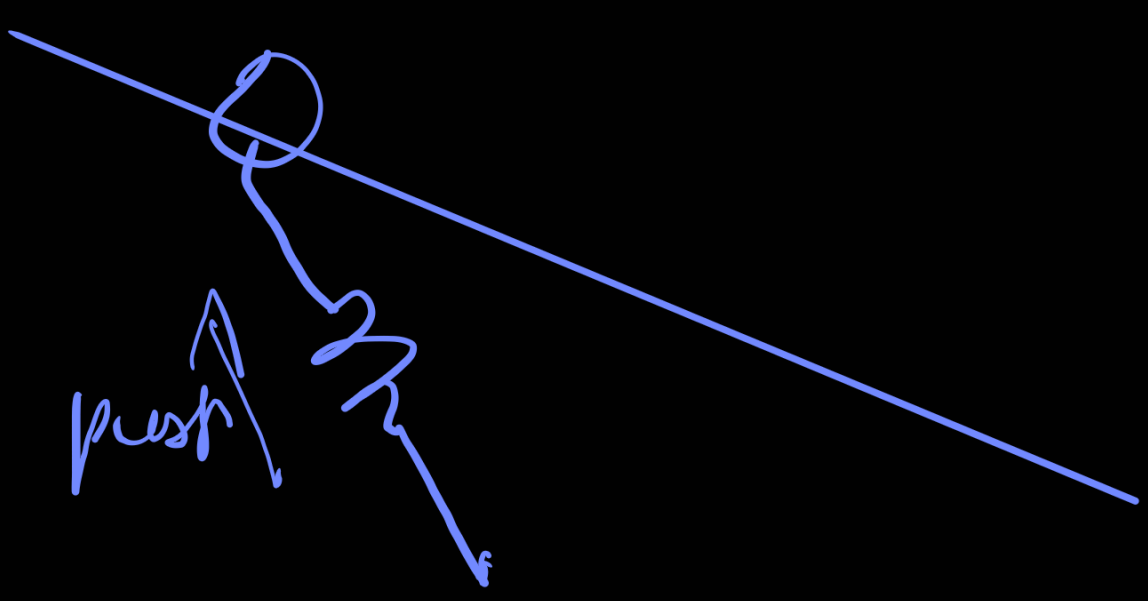
$R = R_c$

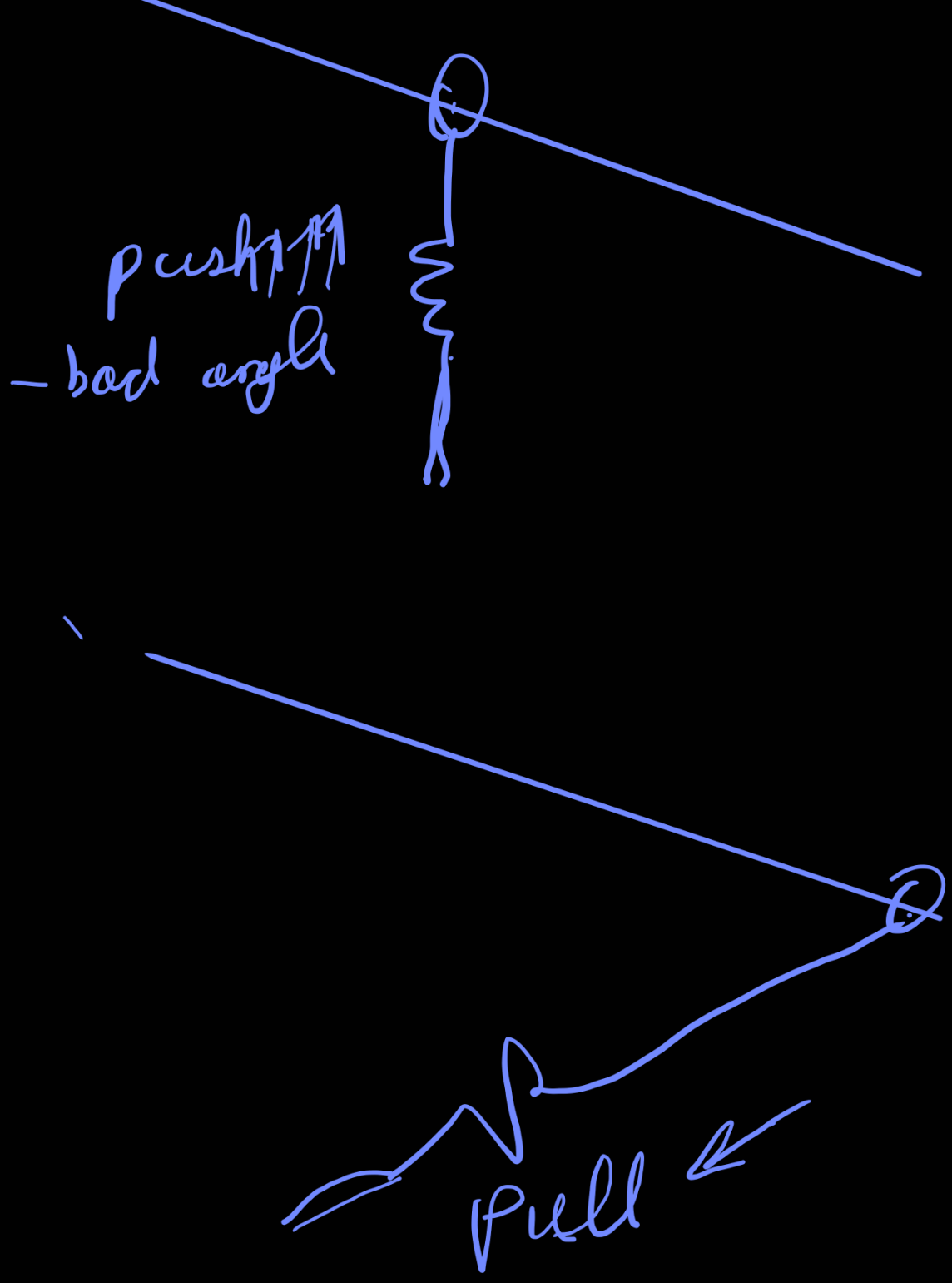

Half stable
h > 0
stable


R
h > 0
Stable

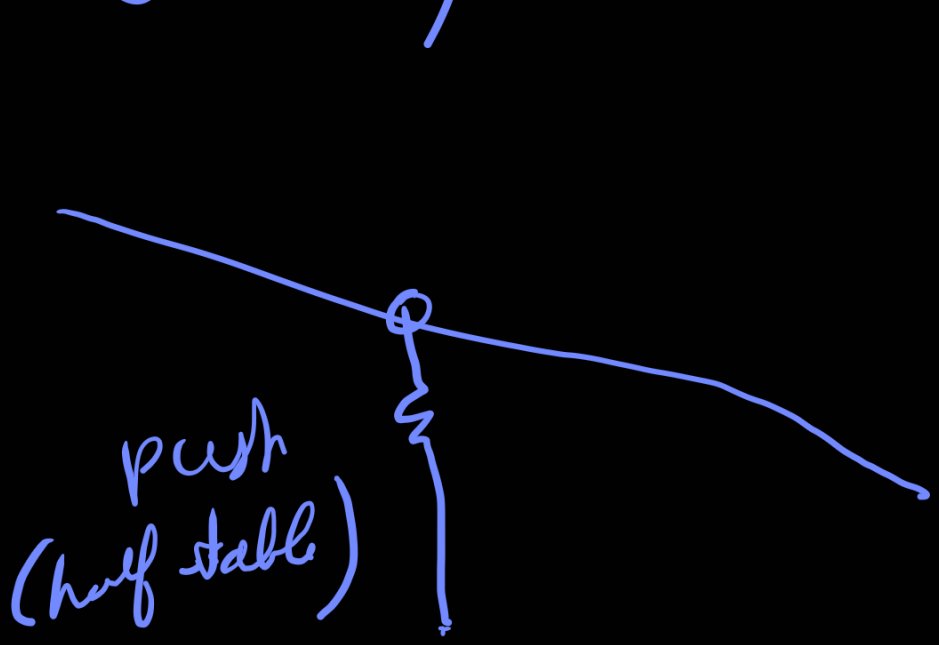
7) Graphs attached

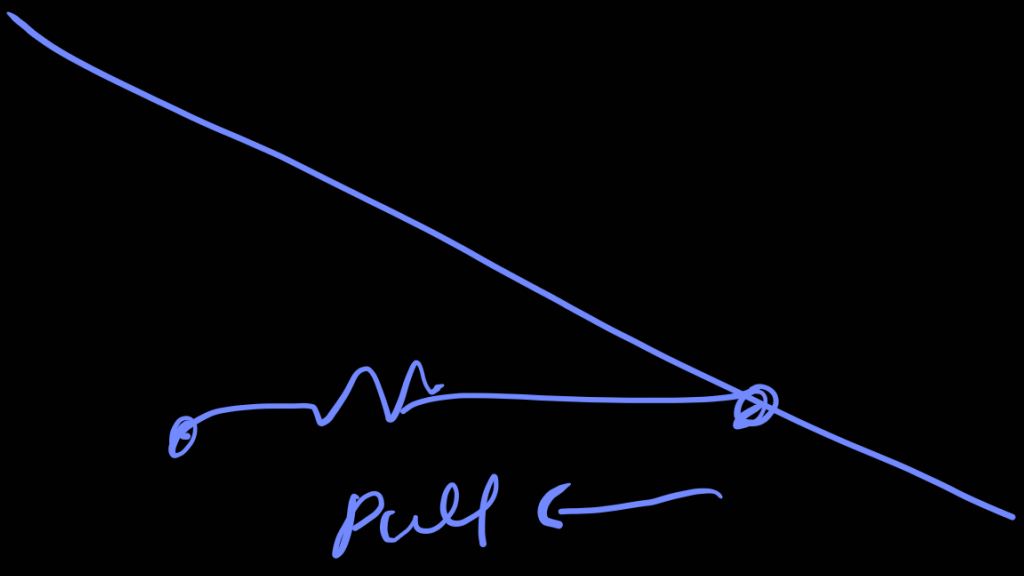
Case 1) Three f.b



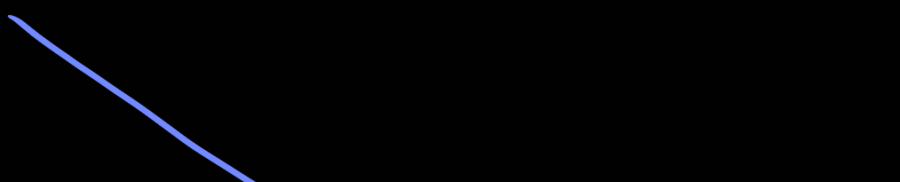


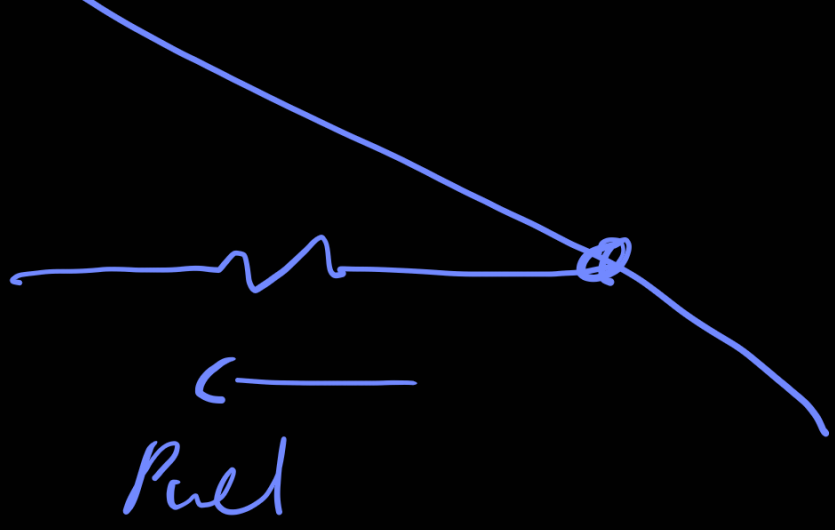
(case 2)





(case 3)




Pull