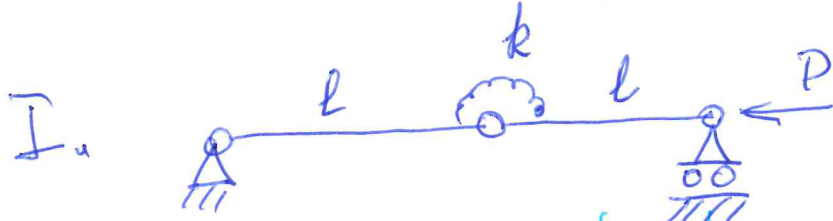
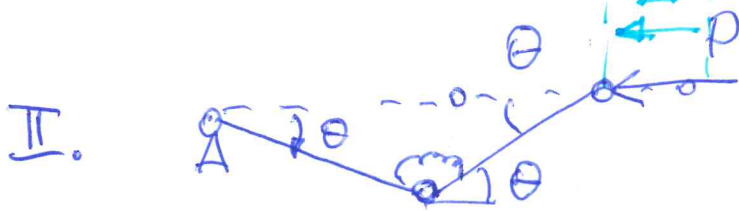


Esempio



$$\theta = \begin{cases} \theta = 0 & \text{I} \\ \theta \neq 0 & \text{II} \end{cases}$$



a) Π -?

$$\Pi = U + V, \quad V = -P\Delta$$

$$U = \frac{1}{2} k \theta^2$$

$$\Rightarrow \Pi = \frac{1}{2} k \theta^2 - P\Delta,$$

$$\Delta = 2l - 2l \cos \theta$$

$$\Rightarrow \boxed{\Pi = \frac{1}{2} k \theta^2 - P 2l (1 - \cos \theta)}$$

b) $\frac{d\Pi}{d\theta} = 0 \quad \frac{d\Pi}{d\theta} = k\theta - 2lP \sin \theta = 0$

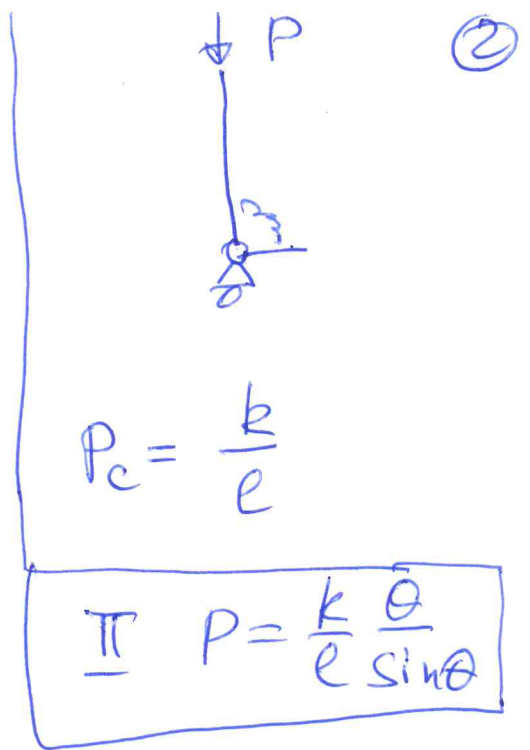
$$\Rightarrow \begin{cases} \text{I. } \theta = 0 \\ \text{II. } P = \frac{k}{2l} \frac{\theta}{\sin \theta} \end{cases}$$

$$P = \frac{k \theta}{2l \sin \theta}$$

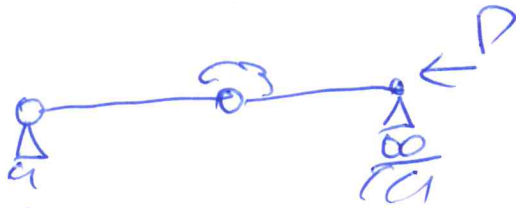
$$P_c = \frac{k}{2l}$$

$$c) \frac{d^2 \Pi}{d\theta^2} = \frac{d}{d\theta} [k\theta - 2lP \sin \theta]$$

$$= k - 2lP \cos \theta$$



① $\theta = 0$



$$\frac{d^2 \Pi}{d\theta^2} = (k - 2lP \cos \theta) \Big|_{\theta=0}$$

$$= k - 2lP = 2l \left[\frac{k}{2l} - P \right]$$

$$= 2l [P_c - P]$$

$$\Rightarrow P < P_c \quad \frac{d^2 \Pi}{d\theta^2} > 0 \rightarrow \text{stable}$$

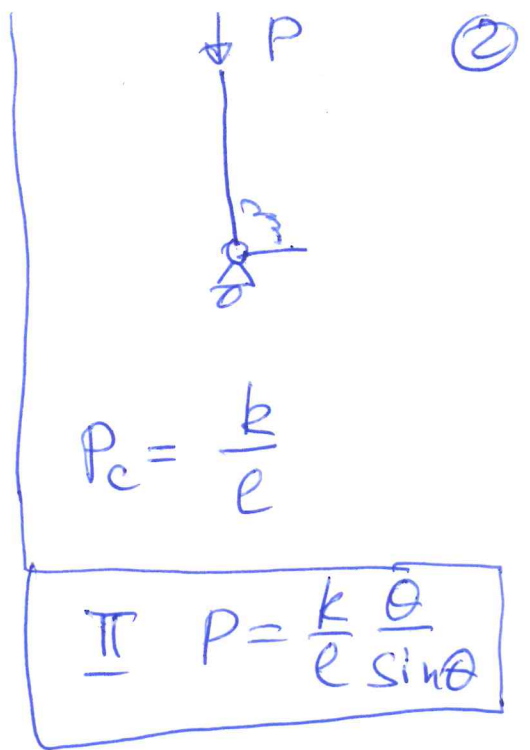
$$P > P_c \quad \frac{d^2 \Pi}{d\theta^2} < 0 \rightarrow \text{instable}$$

$$P = \frac{k \theta}{2l \sin \theta}$$

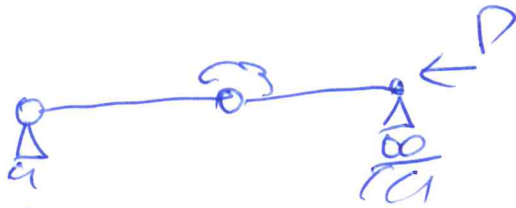
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① $\theta = 0$



$$\frac{d^2 \Pi}{d\theta^2} = (k - 2lP \cos \theta) \Big|_{\theta=0}$$

$$= k - 2lP = 2l \left[\frac{k}{2l} - P \right]$$

$$= 2l [P_c - P]$$

$$\Rightarrow P < P_c \quad \frac{d^2 \Pi}{d\theta^2} > 0 \rightarrow \text{stable}$$

$$P > P_c \quad \frac{d^2 \Pi}{d\theta^2} < 0 \rightarrow \text{instable}$$

4

