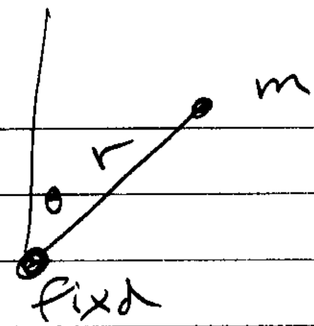
3)



use polar coordinates

$U = mgr \cos\theta$

$T = \frac{1}{2} m r^2 \dot\theta^2 + \frac{1}{2} m r^2 \sin^2\theta \, \dot\varphi^2$

constraint: $r =$ constant

$L = T - U = \frac{1}{2} m r^2 \dot\theta^2 + \frac{1}{2} m r^2 \sin^2\theta \, \dot\varphi^2 - mgr\cos\theta + \lambda(r - c)$

c

θ: $\frac{d}{dt} m r^2 \dot\theta - m r^2 \sin\theta \cos\theta \, \dot\varphi^2 - mgr\sin\theta = 0$

φ: $\frac{d}{dt}(m r^2 \sin^2\theta \, \dot\varphi) = 0$

r: $m r \dot\theta^2 + m r \sin^2\theta \, \dot\varphi^2 - mg\cos\theta + \lambda = 0$

4) $T = \sum f_k(q_k) \, \dot q_k^2$. $\quad V = \sum_k V_k(q_k)$

EL. $\frac{d}{dt}\left(f_k(q_k) \, 2\dot q_k\right) - f_k' \, \dot q_k^2 + V'(q_k) = 0$

each equation only depends on q_k

$\Rightarrow$ problem is separable.