~~Content~~.

$L = T - V$

$T \rightarrow$ Total energy $\rightarrow T_1 + T_2 + T_3 + \ldots$

$V \rightarrow$ Full potential

$\bar{F} = -\bar{\nabla} V$,

Cartesian (x, y, z) co-ordinates, $\bar{F}(x,y,z) = -\bar{\nabla} V(x,y,z)$

$F_x \hat{x} + F_y \hat{y} + F_z \hat{z} = -\left[\hat{x} \frac{\partial V}{\partial x} + \hat{y} \frac{\partial V}{\partial y} + \hat{z} \frac{\partial V}{\partial z}\right)$

$F_x = -\frac{\partial V}{\partial x}$, $F_y = -\frac{\partial V}{\partial y}$ $F_z = -\frac{\partial V}{\partial z}$

$(\rho, \phi, z) \rightarrow$ cylindrical co-ordinate $\bar{F}(\rho, \phi, z) = -\bar{\nabla} V(\rho, \phi, z)$

$F_\rho \hat{\rho} + F_\phi \hat{\phi} + F_z \hat{z} = -\left[\hat{\rho} \frac{\partial V}{\partial \rho} + \hat{\phi} \frac{1}{r} \frac{\partial V}{\partial \phi} + \hat{z} \frac{\partial V}{\partial z}\right)$

$(r, \theta, \phi) \rightarrow$ spherical co-ordinate $\rightarrow$ $\bar{F} = -\bar{\nabla} V(r, \theta, \phi)$

$\bar{F} = F_r \hat{r} + F_\theta \hat{\theta} + F_\phi \hat{\phi} = -\left[\hat{r} \frac{\partial V}{\partial r} + \hat{\theta} \frac{1}{r} \frac{\partial V}{\partial \theta} + \hat{\phi} \frac{1}{r \sin\theta} \frac{\partial V}{\partial \phi}\right]$

$F_r = -\frac{\partial V}{\partial r}$, $F_\theta = -\frac{1}{r} \frac{\partial V}{\partial \theta}$, $F_\phi = -\frac{1}{r \sin\theta} \frac{\partial V}{\partial \phi}$

$T = \frac{1}{2} m (\dot{x}^2 + \dot{y}^2 + \dot{z}^2)$ $\cancel{= \frac{1}{2} m (\dot{\rho}^2 + \rho^2 \dot{\phi}^2}$ (x, y, z) ..

$= \frac{1}{2} m (\dot{\rho}^2 + \rho^2 \dot{\phi}^2 + \dot{z}^2)$, (ρ, ϕ, z) cylindrical.

$= \frac{1}{2} m (\dot{r}^2 + r^2 \dot{\theta}^2 + r^2 \sin^2\theta \, \dot{\phi}^2)$, $(r, \theta, z) \rightarrow$ spherical co-ordinate

2D planes, $T = \frac{1}{2} m (\dot{x}^2 + \dot{y}^2) = \frac{1}{2} m (\dot{r}^2 + r^2 \dot{\theta}^2) \rightarrow (r, \theta)$ plane

~~Ø~~ $\bar{F} = -\bar{\nabla} V$

express F in ~~(x,~~ (x, y, z) / (r, θ, ϕ) / (ρ, ϕ, z)

and V as well.

Exam $F_x = -\frac{\partial V}{\partial x}$ $\quad V = -\int F_x \, \partial x$

$F_\theta = -\frac{1}{r}\frac{\partial V}{\partial \theta}$ $\quad V = -\int r F_\theta \, d\theta$

$F_r = -\frac{\partial V}{\partial r}$ $\quad V = -\int F_r \, dr$

$L = T - V$

use formula of Langrangian

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}}\right) - \frac{\partial L}{\partial q} = 0 \quad \text{for each } q$$

i.e., $q = x, y, z$

$q = r, \theta, \phi$

$q = \rho, \phi, z$