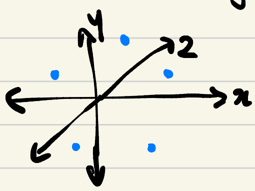
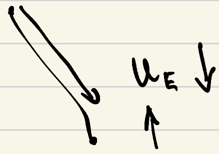
10^{23}

'Degrees of Freedom
Single particle
Gas'



$(x,y,z) = 3$ DOF

$3(10)^{23}$ DOF



If potential energy increases, the work done by the F is negative, meaning that the F is acting opposite to the displacement.

$V(x,y,z)$, Mass $= m$

$r(t) = (y(t), x(t), z(t))$

$r(t) = (\dot{y}, \dot{x}, \dot{z})$

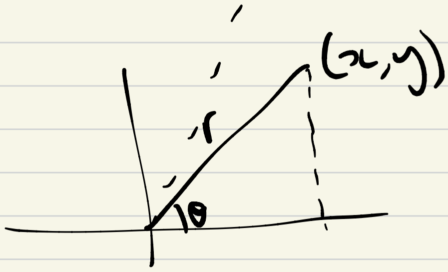
$|r(t)| = \dot{y} + \dot{x} + \dot{z}$

$(x,y) \to y = f(x)$

$\dot{y} = f'(x)$

$y = y(t) \to \dot{y}$

$x = x(t) \to \dot{x}$



Classical

$\text{Magnitude}(r) = |r| = \sqrt{x^2 + y^2}$

(x,y,z)

$\text{mag}(r) = |r| = \sqrt{(x^2 + y^2 + z^2)}$

$E = \frac{1}{2}mv^2 + V$

$= \frac{1}{2}m(\dot{x}^2 + \dot{y}^2 + \dot{z}^2) + V(x,y,z)$

$F = ma$

$\nabla V = \left(\frac{\partial V}{\partial x}, \frac{\partial V}{\partial y}, \frac{\partial z}{\partial z}\right)$

$F = -\nabla V = -\left(e_x \frac{\partial V}{\partial x} + e_y \frac{\partial V}{\partial y} + e_z \frac{\partial V}{\partial z}\right)$