Radioactive Decay

$$\frac{dN}{dt} = -\lambda N \qquad N = N_0 \,,\ t = 0 \rightarrow N = N_0 e^{-\lambda t}$$

Decay eq.

$$\frac{dN}{N} = -\lambda dt \qquad \frac{\Delta N}{N} = -\lambda \Delta t \qquad \frac{N}{N_0} = e^{-\lambda t}$$

$\Delta t = 1 \quad \left| \frac{\Delta N}{N} \right| = \lambda \rightarrow$ Decay prob.

$$\frac{1}{2} = e^{-\lambda t_{1/2}} \qquad \frac{\ln 2}{t_{1/2}} = \lambda$$

p = Decay prob. $\qquad t_{1/2}$ = Half life

$1 - p = 1 - \lambda \Rightarrow$ Survival prob. $\qquad N$ = number of nucle

N_0 = initial N

t = time period

Pendulum motion

1D path $x = x(\theta)$ $y = y(\theta)$

parabola $\Rightarrow x = \theta$ $y = \theta^2$

simple pendulum $\Rightarrow x = \cos(\theta)$ $y = \sin(\theta)$

tautochrone $\Rightarrow x = \sin(2\theta) + 2\theta$ $y = 1 - \cos(2\theta)$

Kinetic Energy $\Rightarrow T = \frac{1}{2} m(x^2 + y^2)$

Potential " $\Rightarrow V = m.g.y$

m= mass
v= velocity
g= acceleration by gravity

Langrangian $\Rightarrow L = T - V$

Lagrange $\Rightarrow \frac{dL}{d\theta} - \frac{d}{dt} \cdot \frac{dL}{d\theta} = 0$

solve. LE theDD (0) $\Rightarrow \frac{d\theta}{dt} = \omega \Rightarrow \frac{d\omega}{dt} = \frac{d\theta^2}{dt^2}$

Gas particles

random particles (400) $r(0) = x$ $r(1) = y$

if $r(0) > 0.5$ => right (red)

if $r(0) <= 0.5$ => left (blue)

id every particle   500 m/s speed of particles

$v(0) = x$ velocity
$v(1) = y$ "

right particles => -500

left " => 500

id of all possible pairs $(400.(400-1)/2)$

x and y values of pair then $d_{ij} = \sqrt{\Delta x_{ij}^2 + \Delta y_{ij}^2}$

getting differences or delta   Euclidean distance

if distance between particles < 2 radius => collision

particles in left 1

" " right 2

$$\vec{v}_1^{\,new} = \vec{v}_1 - \frac{(\vec{v}_1 - \vec{v}_2).(\vec{r}_1 - \vec{r}_2)}{|\vec{r}_1 - \vec{r}_2|} \cdot (\vec{r}_1 - \vec{r}_2)$$

$$\vec{v}_2^{\,new} = \vec{v}_2 - \frac{(\vec{v}_2 - \vec{v}_1).(\vec{r}_2 - \vec{r}_1)}{|\vec{r}_2 - \vec{r}_1|} \cdot (\vec{r}_2 - \vec{r}_1)$$

box will have elastic properties, particles bounce back with same velocity

Creating a histogram with Maxwell-Boltzmann eq in 2D and comparing with Velocity Distribution from animation

$$kt = \underset{\text{avg}}{KE} = \frac{1}{2} m \vec{v}^2 \Rightarrow \frac{m}{kt} = \frac{2}{\vec{v}^2}$$

Kinetic Energy avarage

$$f(v) = \frac{m}{kT} \cdot v \cdot \exp\left(-\frac{m}{kT} \cdot \frac{v^2}{2}\right)$$