Chapter 4 ⇝ Energy

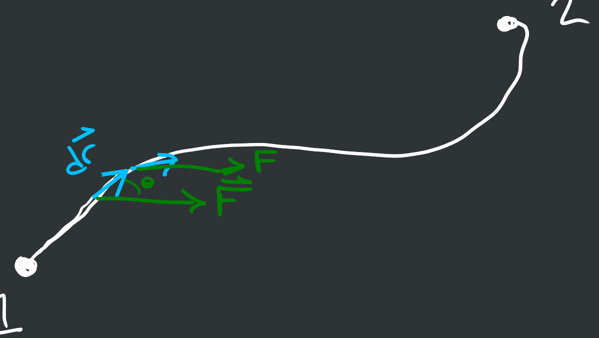
- Kinetic Energy

$$T = \frac{1}{2}mv^2 = \frac{1}{2}m\vec{v}\cdot\vec{v} = \frac{p^2}{2m}$$

- Work is a transfer of energy to the system

$$dW = \vec{F}\cdot d\vec{r} \Rightarrow W = \int_1^2 \vec{F}\cdot d\vec{r}$$

$|\vec{F}|\cdot|d\vec{r}|\cdot\cos\theta$



path integral means work depends on the path between points, unless it doesn't

- Amount of work done (total) is the same as the change in kinetic energy

$W = \Delta T$ ← Work-Kinetic energy theorem

- If the work done does not depend on the path taken, (it depends on the end points (positions)), that force is a conservative force

→ work done by a conservative force ⇒ potential energy

$$\Delta U = -W_{\substack{\text{conservative} \\ \text{force}}}$$

Conservative forces	nonconservative force
- gravitational force	- friction
- electric force	- drag
- spring force	- "applied force"

* potential energy is defined by a reference point ($\vec{r}$ when $U=0$)

- Conservation of energy

$$W = \Delta K$$

$$W_{NC} = \underbrace{\Delta K + \Delta U}_{\text{mechanical energy}}$$

$$U_g = mgh$$

$$W_{NC} = T_f - T_i + U_f - U_i$$

$$T_i + U_i + W_{NC} = T_f + U_f$$

- if $\Delta U = -\int_1^2 \vec{F} \cdot d\vec{r} \Rightarrow$

$$dU = -W = -\vec{F} \cdot d\vec{r}$$

$$\cancel{\frac{dU}{d\vec{r}} = -\vec{F}}$$

$$\vec{F} = -\vec{\nabla} U = \frac{\partial U}{\partial x}\hat{x} + \frac{\partial U}{\partial y}\hat{y} + \frac{\partial U}{\partial z}\hat{z}$$

gradient cartesian

$$F = -\frac{dU}{dx}$$ ← one dimension

- What make a F conservative
  - F depends only on position (not v, t, a)
  - Work is path-independent

$F_s = -kx$

→ $F_g = mg$

$F_G = \frac{G m_1 m_2}{r^2}$

$F_D = bv$

$= cv^2$