§2-1

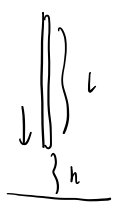
1. $\vec{r} = \dfrac{\int \vec{r}\,dm}{m}$ 质心坐标

2. 内力无法改变质心坐标.
故内心仅受外力影响.
例如：当一个Bomb爆炸之后，其质心会沿原轨迹运动

§2-2

1. 动量应当在同一个惯性系中测量

2. 典：链条问题：



设 t 时刻已有 x 长落到地面处.
dt 内有 dx 继续下落. $\rho = \dfrac{m}{L}$

$dx = v\,dt$　　$dm = \rho\,dx$

$F\,dt = -(dm)\cdot v = -\dfrac{m}{L} v\,dx$

$\therefore F = -\dfrac{m}{L} v \dfrac{dx}{dt} = -\dfrac{m}{L} v^2$

而 $v^2 = 2g(x+h)$
↑对一个质元而言

$\therefore F = \dfrac{m}{L}\cdot 2g(x+h)$

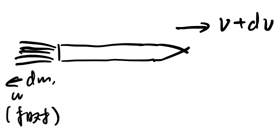
代入 $x = L$

3. 注意 发射炮弹都是"相对炮口"速度

要记得 $\vec{u}_{炮地} = \vec{u}_{炮车} + \underbrace{\vec{u}_{车地}}_{往往是负的}$

4. 变质量物体：设火箭质量m. 喷走dm. 速度增加dv $(dm<0)$

$mv = (m+dm)(v+dv) - dm(v+dv-u)$



展开后忽略二阶小量. 有 $m\,dv + u\,dm = 0$

$\Longrightarrow dv = -u\dfrac{dm}{m}$

$\int_{v_1}^{v_2} dv = \int_{m_1}^{m_2} -u\dfrac{dm}{m}$

$v_2 - v_1 = u\ln\dfrac{m_1}{m_2}$

§2-3

1. $L = p \times r = mvr$

2. $\vec{L} = \vec{r} \times \vec{p}$　　有心力场角动量守恒

3. 角动量定理：

$\dfrac{d\vec{L}}{dt} = \dfrac{d}{dt}(\vec{r}\times\vec{p}) = \dfrac{d\vec{r}}{dt}\times\vec{p} + \vec{r}\times\dfrac{d\vec{p}}{dt}$

又 $\dfrac{d\vec{r}}{dt} = \vec{v}$,　$\vec{v}\times \underbrace{m\vec{v}}_{p} = 0$

$\therefore \dfrac{d\vec{L}}{dt} = \vec{r}\times\dfrac{d\vec{p}}{dt} = \vec{r}\times\vec{F} = \underbrace{\vec{M}}_{力矩}$

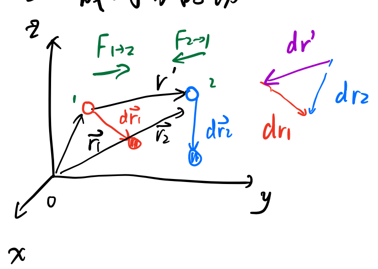
§2-4

1. 能量是物体状态的单值函数

§2-5.

1. 保守力F：$\oint_L \vec{F}\cdot d\vec{r} = 0$

2. 成对力的功：



一对成对力做功和：

$dA = \vec{F}_{12}\cdot d\vec{r}_1 + \vec{F}_{21}\,d\vec{r}_2$

$= \vec{F}_{12}\cdot d\vec{r}_1 + \vec{F}_{21}(d\vec{r}_1 + d\vec{r}')$

$= \underbrace{(\vec{F}_{12}+\vec{F}_{21})}_{0}d\vec{r}_1 + \vec{F}_{21}\,d\vec{r}'$

一对力做功之和与参考系无关. 仅与相对位移有关 $\boxed{= \vec{F}_{21}\cdot d\vec{r}'}$

3. 势能：$A_c = E_{pa} - E_{pb} = -\Delta E_p$

成对保守内力做功 = 势能减少量
(保守力做功)

4. $F_x = -\dfrac{dE_p}{dx}$

§ 2-6

1. $A_e + A_i = \Delta E_k$

系统外力做功　　系统内力做功

$= A_{ic} + A_{id}$

保守力　　非保守力

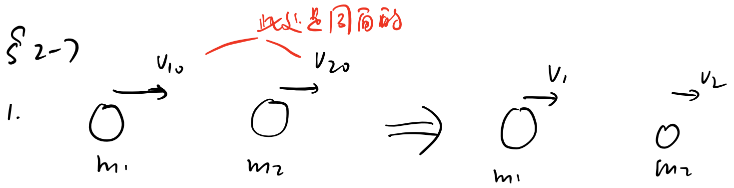
$A_{ic} = -\Delta E_p$

$A_e + A_{id} = \Delta E_k + \Delta E_p = \Delta E$

保守内力做功与势能变化必且只选其一

§ 2-7

1.



定义：$e = \dfrac{v_2 - v_1}{v_{10} - v_{20}}$

$$\begin{cases} v_1 = v_{10} - \dfrac{(1+e)m_2(v_{10}-v_{20})}{m_1+m_2} \\ v_2 = v_{20} + \dfrac{(1+e)m_1(v_{10}-v_{20})}{m_1+m_2} \end{cases}$$

代入 $e=1$：$v_1 = v_{10} - \dfrac{2m_2(v_{10}-v_{20})}{m_1+m_2} = \dfrac{(m_1-m_2)v_{10} + 2m_2 v_{20}}{m_1+m_2}$

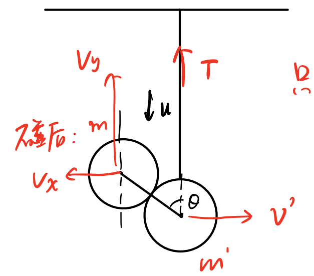
$v_2 = v_{20} + \dfrac{2m_1(v_{10}-v_{20})}{m_1+m_2} = \dfrac{(m_2-m_1)v_{20} + 2m_1 v_{10}}{m_1+m_2}$

损失机械能

$\Delta E = \dfrac{1}{2}(1-e^2)\dfrac{m_1 m_2}{m_1+m_2}(v_{10}-v_{20})^2$

2. 在斜碰中，考虑"速度差"

→ 选取连心线方向上分量进行研究



只有水平方向可进行分析

（y上有绳子冲量T）

$mv_x + m'v' = 0$

☆ 考虑在连心线上二球冲力F

动量定理：

$mv_x = -F\sin\theta\,\Delta t$

$mv_y - (-mu) = F\cos\theta\,\Delta t$

结合 连心线方向分离速度

$-(v'-v_x)\sin\theta - v_y\cos\theta$

接近 $-u\cos\theta$

$\Rightarrow e = \dfrac{-(v'-v_x)\sin\theta - v_y\cos\theta}{-u\cos\theta}$

$\rightarrow v_x = \cdots$

$v_y = \cdots$