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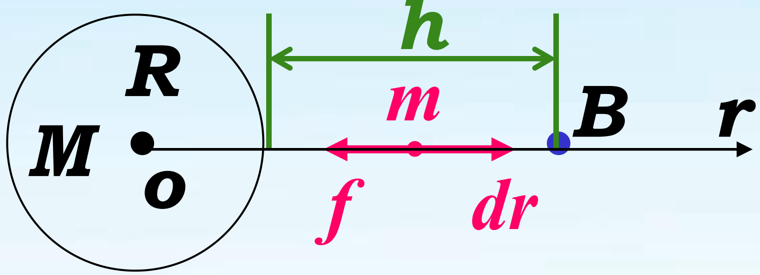
[讨　论]取地表为0势, 地球 M, R, m 位于 B, 求 E_{BR}



解:方法1 $\boxed{A_{保} = -\Delta E_p}$

B→地表 $A_{保} = \int_{h+R}^{R} -G\frac{Mm}{r^2}dr = GMm\frac{h}{R(R+h)} = -(0-E_{BR})$

$$E_{BR} \approx GMm\frac{h}{R^2} \longleftarrow \text{若 } h \ll R \rightarrow R(R+h) \approx R^2$$

$\Rightarrow E_{BR} \approx mgh$ 重力势能是引力势能在地表附近的特例

方法2 相对比较

$$E_{B\infty} = -G\frac{Mm}{h+R}$$

$$E_{R\infty} = -G\frac{Mm}{R}$$

$$\Rightarrow E_{BR} = E_{B\infty} - E_{R\infty}$$

[例2-3]m沿1/4圆周R, 由静止从A滑到B(v_B),
求A→B摩擦力功.

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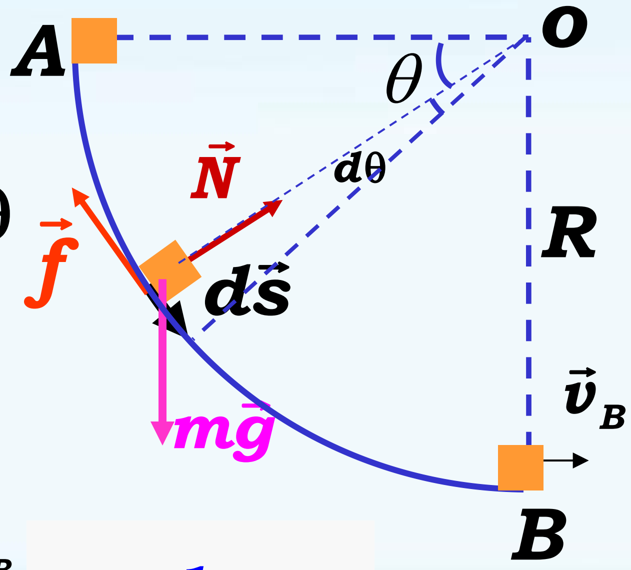
解:(1) 由功的定义



$$A_f = \int f ds\cos\varphi = -\int_0^{\frac{\pi}{2}} fRd\theta$$

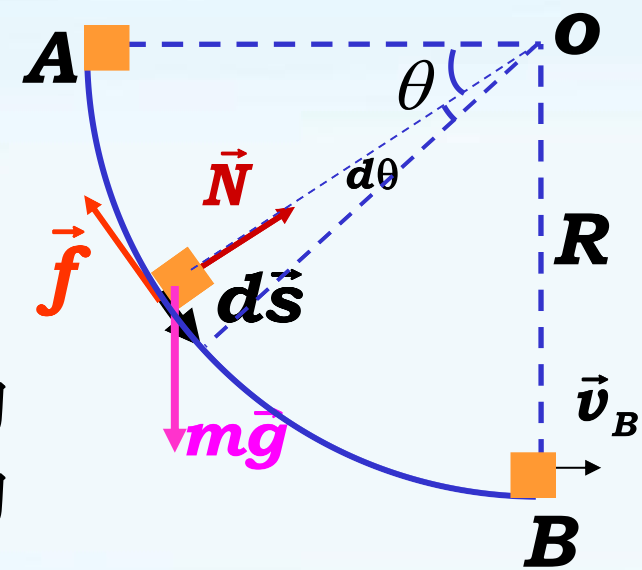
$$\vec{e}_t: \quad f = mg\cos\theta - m\frac{dv}{dt}$$

$$A_f = -\int_0^{\pi/2} mg\cos\theta R d\theta + \int_0^{v_B} mvdv$$

$$= -mgR + \frac{1}{2}mv_B^{\ 2}$$

[例2-3]m沿1/4圆周R，由静止从A滑到B(v_B)，求A→B摩擦力功.

(2)由动能定理



$$A_{all} = E_{kB} - E_{kA}$$

$$\text{所有力}\begin{cases} mg \begin{cases} mg\cos\theta & \text{——做功} \\ mg\sin\theta & \text{——不做功} \end{cases} \\ N & \text{——不做功} \\ f & \text{——做功} \end{cases}$$

$$\therefore A = A_{mg\cos\theta} + A_f = \int_0^{\pi/2} mg\cos\theta R d\theta + A_f = mgR + A_f$$

$$= \frac{1}{2}mv_B^2 - \frac{1}{2}mv_A^2 \to A_f = \frac{1}{2}mv_B^2 - mgR$$

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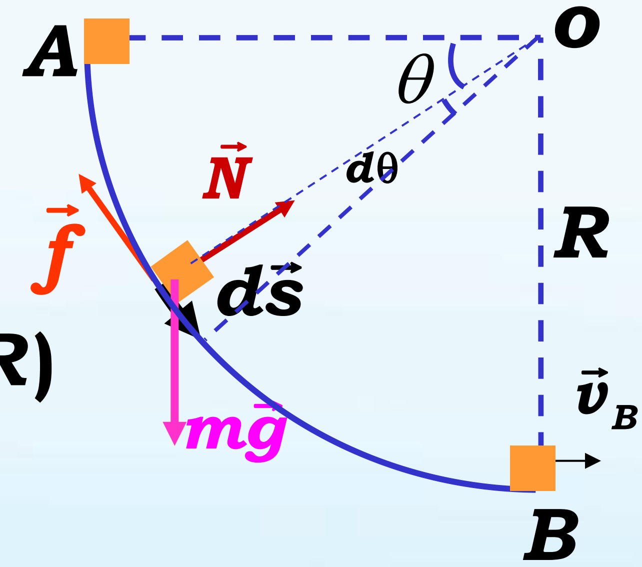
[例2-3]m沿1/4圆周R, 由静止从A滑到B(v_B)，
求A→B摩擦力功.

(3) 由功能原理

选m、地球为系统 $A_{外}+A_{非保内}=E_B-E_A$

$$\text{非保守力}\begin{cases}\text{外力}\begin{cases}N:\ \text{不做功}\\ f:\ \text{做功}\end{cases}\\ \text{非保内:无}\end{cases}$$



$$\therefore A_f=(\frac{1}{2}mv_B{}^2+0)-(0+mgR)$$

$$=\frac{1}{2}mv_B{}^2-mgR$$

比较动能定理、功能原理: $\boxed{\text{先功能、后动能}}$

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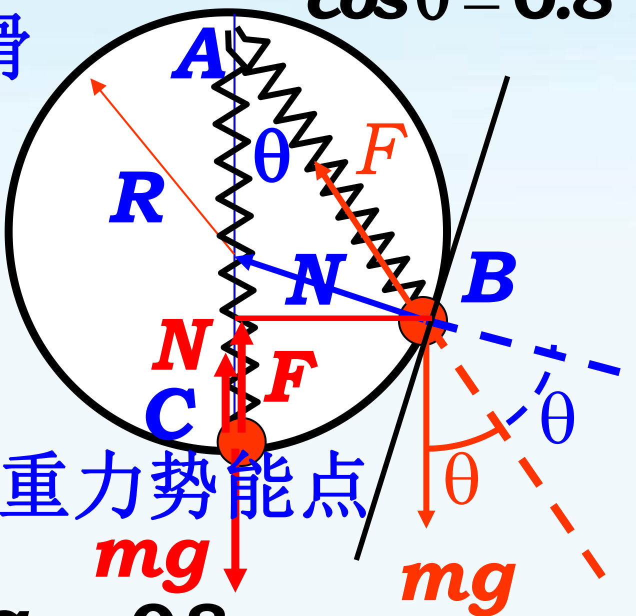
[例2-4]弹簧原长R, 下挂m长$2R$. 光滑环R

初始$B, AB=1.6R$,重物无初速下滑

分别求:a和N(1)滑到C; (2)在B

(状态与过程; 机械能)

$\cos\theta = 0.8$



零重力势能点

解:(1) $N + F - mg = ma_n$

$F = kR = mg$

$a_n = v_c^2 / R$

$E_C = E_B \Rightarrow \frac{1}{2}kR^2 + \frac{1}{2}mv_c^2 = \frac{1}{2}k(0.6R)^2 + mg(2R - 1.6R\cos\theta)$

$\Rightarrow \begin{cases} a = a_n = 0.8g \\ N = 0.8mg \end{cases}$

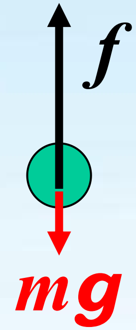
(2) 切向 $ma_t = mg\cos(90^\circ - 2\theta) - F\cos(90^0 - \theta)$

法向 $F\cos\theta + N - mg\cos 2\theta = 0$

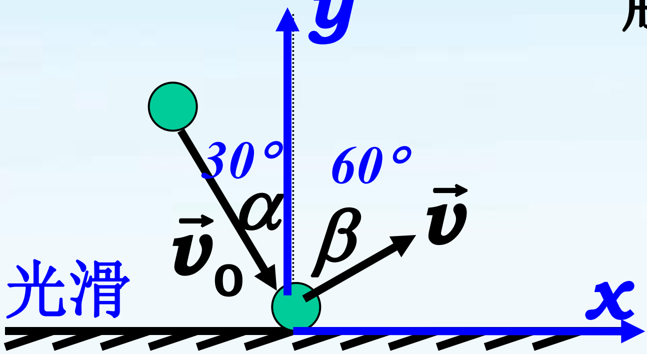
$F = 0.6kR = 0.6mg$

$\Rightarrow \begin{cases} a = a_t = 0.6g \\ N = -0.2mg \end{cases}$

[例2-5]$m=0.2Kg, v_0=8m/s, \Delta t=0.01s$,求 $f_{球对地}$



解:选球　建系（碰）受力 方程



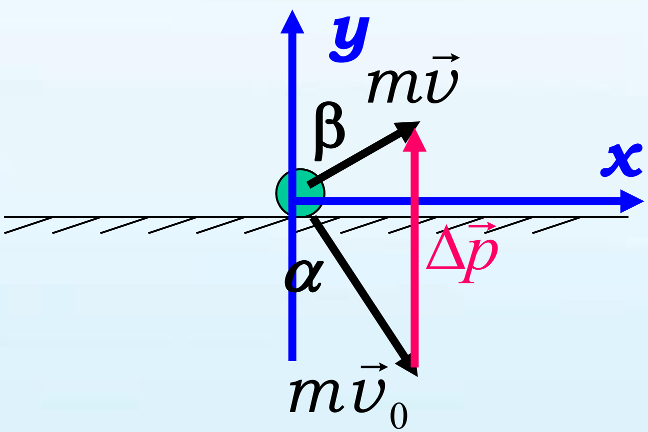
$$I_{合x}=p_x-p_{x0}\Rightarrow 0=mv\sin\beta-mv_0\sin\alpha$$

$$I_{合y}=p_y-p_{y0}\Rightarrow (f-mg)\Delta t=mv\cos\beta-(-mv_0\cos\alpha)$$

$$\Rightarrow f=mg+mv_0\sin(\alpha+\beta)/[\sin\beta\Delta t]=187N$$

解:矢量图示法

$$\vec{I}_{合}=\Delta\vec{p}\Rightarrow I_{合y}=\Delta p_y$$



$$\Rightarrow (f-mg)\Delta t=\frac{mv_0}{\cos\alpha}\Rightarrow f=mg+\frac{mv_0}{\cos\alpha\Delta t}$$

若不计重力, $f'=\dfrac{mv_0}{\cos\alpha\Delta t}=185N\approx f$

→碰撞过程重力可忽略

[讨 论]α＝30°，β＝45°，$\Delta\vec{p}$是否⊥地面

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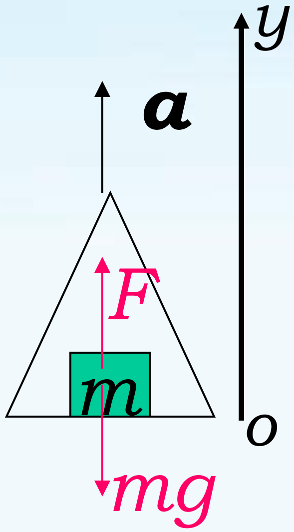
[讨 论]已知m=10Kg,a=3+5t(SI),作用0~2s

求：$I_{底板对物}$, $\Delta p_{物}$



解：受力

(1) $$\left.\begin{aligned} I &= \int_0^2 F dt \\ F - mg &= ma \end{aligned}\right\} \Rightarrow I = \int_0^2 m(g+a)dt$$

$$= \int_0^2 10\times(9.8+3+5t)dt = 356N\cdot s$$

(2) $$\left.\begin{aligned} \Delta p = I_{合} &= 365N\cdot s \\ I_{合} &= \int_0^2 F_{合} dt \\ F_{合} &= ma \end{aligned}\right\} \Rightarrow \Delta p = \int_0^2 madt$$

$$= \int_0^2 10\times(3+5t)dt = 160N\cdot s$$

[讨 论]f作用质点：$m=1.0$, $x=3t-4t^2+t^3$,

0~4内, f冲量I?

解：$v = dx/dt = 3 - 8t + 3t^2$ $\begin{cases} v_0 = 3 \\ v_4 = 19 \end{cases}$

$\Rightarrow a = dv/dt = -8 + 6t \Rightarrow f = -8 + 6t$

求 I $\begin{cases} \text{由定义 } I = \int_0^4 f \cdot dt = \int_0^4 (-8+6t) \cdot dt = 16 \\ \text{由动量定理 } I = \Delta p = mv_4 - mv_0 = 16 \end{cases}$

求过程量I (A)可用状态量变化Δp (ΔE_k) 来表示

代数运算 $\xrightarrow{\text{替换}}$ 积分运算

请与[例2-1]对比