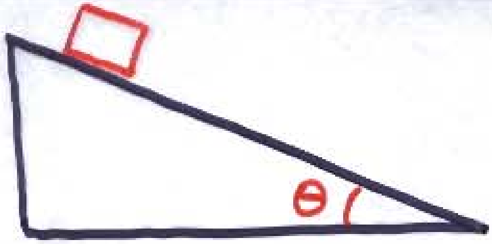
Lessons from Homework

1. Start Early!
2. Work symbolicly (Eg. Ch. 6, #8)
3. Point Friction Force Right (Eg. Ch. 6, #20)
4. If static/kinetic unknown
   $\Rightarrow$ assume static & check (Eg. Ch. 6, #30)
5. Watch units! (Eg. Ch. 6, #50)

$$\tan\theta = \frac{v_0^2}{Rg} = \frac{(60\ \mathrm{km/h})^2}{(200\mathrm{m})(9.8\ \mathrm{m/s^2})} \cong .1417 \neq 1.8367$$

$$\Rightarrow \theta \cong 8.06^\circ \neq 61.43^\circ$$

6. Centripetal $\vec{a}$ caused by known forces
   Eg. Ch. 6, #52



Block takes 3 times as long to slide down with friction as without. Find μ_k.

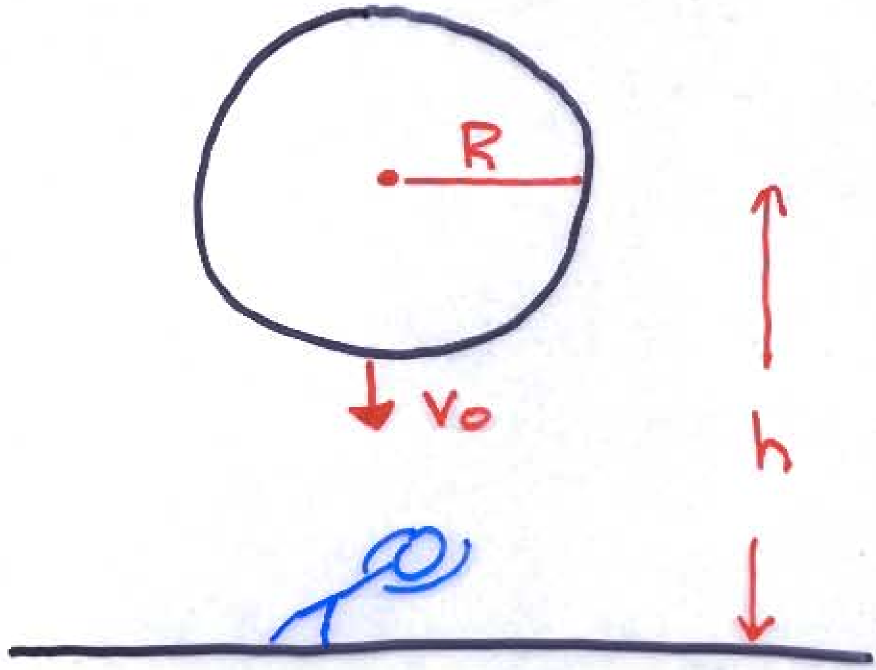
(A) $\frac{1}{3}\tan\theta$

(B) $\frac{1}{2}\tan\theta$

(C) $\frac{3}{4}\tan\theta$

(D) $\frac{8}{9}\tan\theta$

(E) $\tan\theta$



3 km

V

A spherical asteroid made of iron ($\rho \cong 7.9\ g/cm^3$) drops from $h = 100$ km with $v_0 = 10^4$ km/h. What is its kinetic energy in megatons ($1\ \text{M-ton} \cong 4.2\times10^{15}$ J) upon impact?

(A) 1

(B) 10^2

(C) 10^4

(D) 10^6

(E) 10^8

Recall K and W

(1) $K = \frac{1}{2} m \vec{v} \cdot \vec{v}$

(2) $dW = \vec{F} \cdot d\vec{x}$

(a) Normal Force	$dW = 0$
(b) Static Friction	$dW = 0$
(c) Kinetic Friction	$dW = -\mu_k N \lVert d\vec{x} \rVert$
(d) Gravity	$dW = -mg\,dh$
(e) Springs	$dW = -kx\,dx$

(3) $\Delta K = \Delta W_{tot}$

Conservative Forces

Def: zero work done around any closed path

* Kinetic Friction? $\Rightarrow$ no
* Gravity? $\Rightarrow$ yes
* Springs? $\Rightarrow$ yes

Potential Energy

$$\oint \vec{F} \cdot d\vec{x} = 0 \Leftrightarrow \int_1^2 \vec{F} \cdot d\vec{x} = -\left\{ P(\vec{x}_2) - P(\vec{x}_1) \right\}$$

* NB the constant is arbitrary!
* Gravity: $dW = -d(mgh) \Rightarrow \boxed{P = mgh}$
* Springs: $dW = -d(\frac{1}{2}kx^2) \Rightarrow \boxed{P = \frac{1}{2}kx^2}$

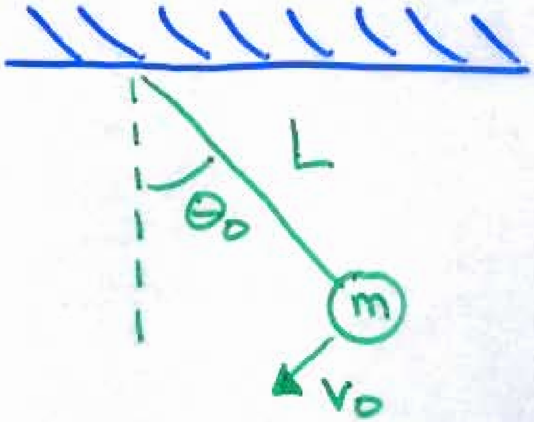
Cons. of Mechanical Energy

① W-E Thm : $K_2 - K_1 = \int_1^2 \vec{F} \cdot d\vec{x}$

② Suppose $\vec{F}$ is conservative : $\int_1^2 \vec{F} \cdot d\vec{x} = -[P_2 - P_1]$

$\therefore K_2 - K_1 = -P_2 + P_1 \Rightarrow \boxed{K_2 + P_2 = K_1 + P_1 \equiv E}$

Application : The Pendulum



$$\Rightarrow v(\theta) = \sqrt{v_0^2 + 2gL[\cos(\theta) - \cos(\theta_0)]}$$

* how fast at $\theta = 0$? $\Rightarrow \sqrt{v_0^2 + 2gL(1 - \cos\theta_0)}$

* how high does it go?

$$\Rightarrow \cos(\theta) = \cos(\theta_0) - \frac{v_0^2}{2gL}$$