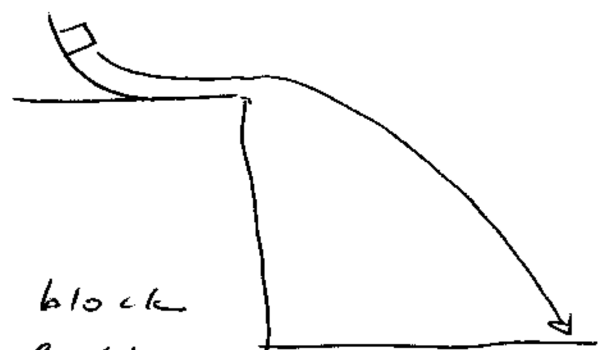
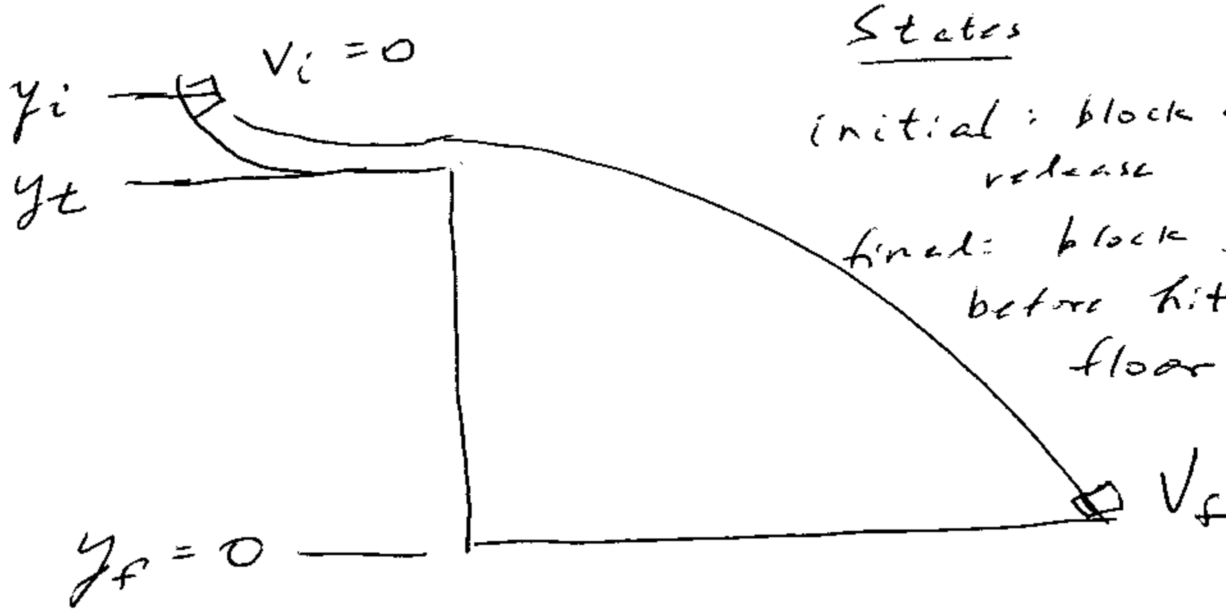
A block is released from rest on a curved ramp and slides frictionlessly down the ramp and along a table. The block leaves the table and is projected to floor.

<u>Given</u>: - height of table
- height of ramp

<u>Goal</u>: speed of block just before hitting floor





<u>States</u>

initial: block at release

final: block just before hitting floor

System

block
Earth

Ext. Forces

normal of ramp
and table
(do no work since
$\vec{N} \perp \vec{d}$)

~~Solutio~~ Energy Changes

$\Delta K > 0$
$\Delta U_g < 0$

Solution

$W_{ext} = \Delta E_{sys}$

$W_N = \Delta K + \Delta U_g$

$0 = K_f - \cancel{K_i}^{0} + \cancel{U_{gf}}^{0} - U_{gi}$

$K_f = U_{gi}$

$$\frac{1}{2} \cancel{m} v_f^2 = \cancel{m} g y_i$$

$$v_f = \pm\sqrt{2 g y_i} \quad (\text{pick } +)$$

Checks: Pick + root since
v_f is a magnitude

$2 g y_i$ is +; ~~+~~ $\sqrt{2 g y_i}$ is real

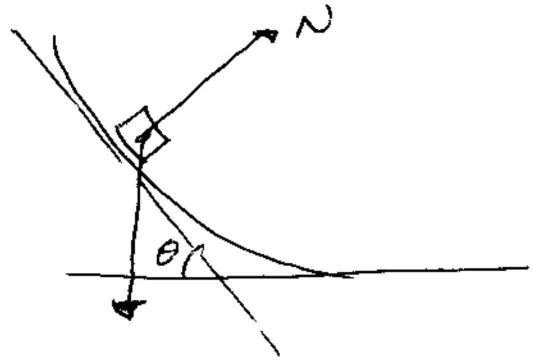
Units: $\sqrt{\frac{m}{s^2} \cdot m} = \frac{m}{s}$ ✓

What we can't find with the above method:

- forces and accelerations
- times
- components of the velocity (unless we first find the velocity with which the ball leaves the table)

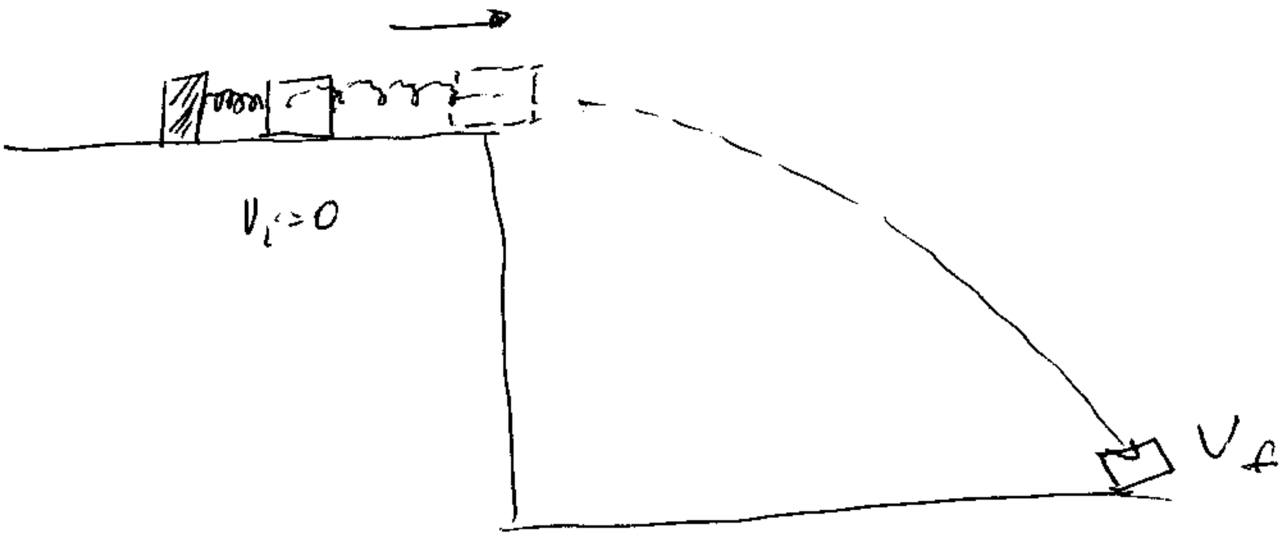
Could we solve the problem using net force / dvat methods?

Consider the curved ramp:



The forces on the block are N + mg. At the instant of time shown, the angle of the ramp with the table is θ. We know from previous problems that $a = g\sin\theta$; however, θ is a function of time in this situation. That means a is a function of time; therefore, we can't use dvats.

Suppose the block is pushed off the table with a spring.

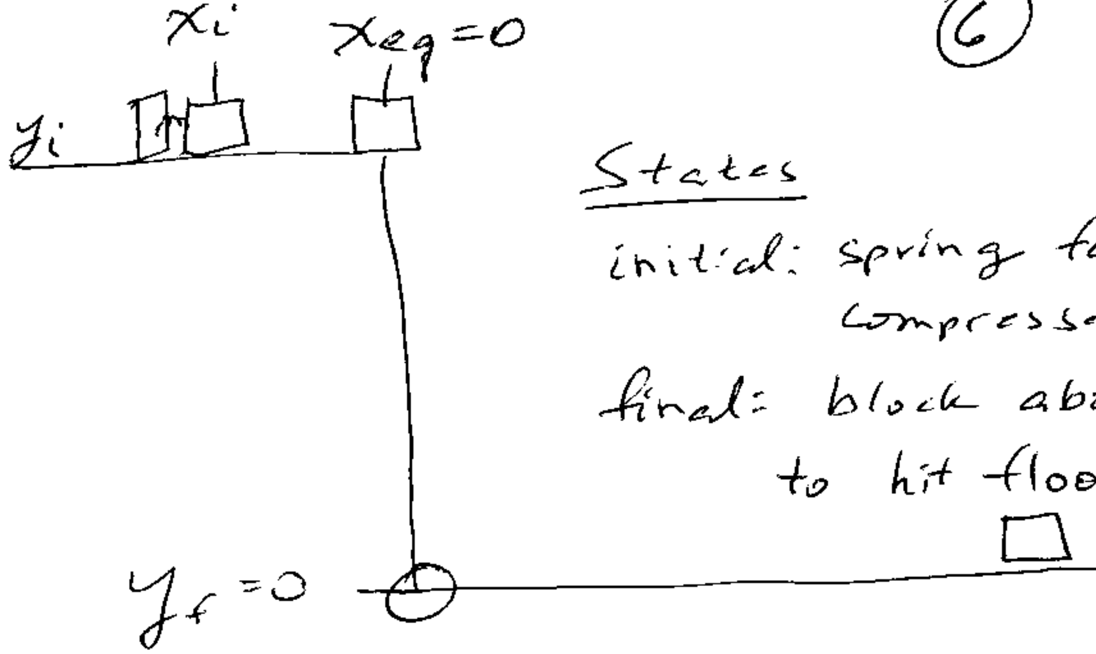


Given: m of block, k of spring, height of table, compression of spring

Goal: V_f

We make the lowest point $y_f=0$.

We set $\cancel{x_0=0}$ $x_{eq}=0$ at the point where the block leaves the table. This is the relaxed position of the spring.



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States

initial: spring fully compressed

final: block about to hit floor

System	Ext. Forces	ΔEnergy
block	N of table	$\Delta K > 0$
Earth	(does no	$\Delta U_g < 0$
spring	work)	$\Delta U_e < 0$

$$W_{ext} = \Delta E_{sys}$$

$$W_N = \Delta K + \Delta U_g + \Delta U_e$$

$$0 = (K_f - \cancel{K_i}^{\,0}) + (\cancel{U_{gf}}^{\,0} - U_{gi}) + (\cancel{U_{ef}}^{\,0} - U_{ei})$$

$$K_f = U_{gi} + U_{ei}$$

$$\frac{1}{2} m v_f^2 = m g y_i + \frac{1}{2} k x_i^2$$