Blocks Sliding Down Ramps, and All That

Problem Sheet

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Solutions available at PhysicsWithElliot.com/block-ramp-help-room

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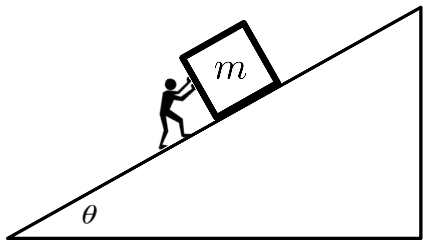
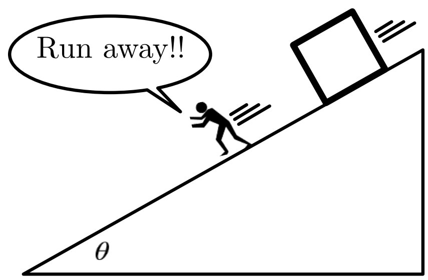


Sisyphus is carrying on with his daily punishment, as Zeus has commanded he shall for every day to come until the end of time, pushing his rock up a hill.

Suppose the hill is a ramp inclined at an angle θ, and the rock is a block of mass m. Let the coefficient of kinetic friction between the block and the hill be μ_{K}.

(**a**) How hard must Sisyphus push if he wants to keep the rock moving up the hill at constant speed?

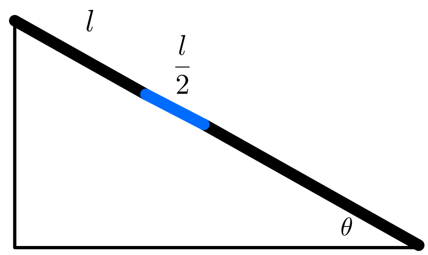


As usual, Sisyphus is able to push the block just barely to the top of the hill, before his strength gives way and the rock begins to fall back down.

(**b**) How fast must Sisyphus run back down the ramp if he is to avoid being crushed by the rock that is sliding down behind him? (Picture the opening scene of Indiana Jones, but instead of a giant rolling ball chasing Harrison Ford it's a giant block sliding after Sisyphus.) Assume Sisyphus runs with constant speed the whole time, that the block starts from rest, and that he and the rock both start at the top of the ramp of length l.

(**c**) Assuming Sisyphus *just* barely makes it to the bottom of the hill and dives out of the way before the rock almost hits him, how fast is the rock moving at that instant?

2



It's a beautiful winter's day, and you're out snowboarding. You start out coasting down a straight stretch of snow, when suddenly you hit a patch of ice!

Suppose the hill is a straight ramp inclined at an angle θ. Let the length of the initial snow patch be l and the length of the ice patch be $l/2$. You kick off from the top of the hill at $t = 0$ with initial speed v_0, and then you slide down without propelling yourself. The coefficient of kinetic friction between your board and the snow is μ_K, and the ice is completely frictionless.

(**a**) How long is the initial, pleasant period of your trip, before it's upended by the ice?

(**b**) How fast are you moving when you first hit the ice?

(**c**) By how much has your kinetic energy $\frac{1}{2}mv^2$ increased when you reach the end of the initial snow patch? Is it equal to the change in the gravitational potential energy $mg\Delta y$? Explain.

You hit the ice, but do your best to keep your cool, knowing that if you just coast for a bit you're sure to end up back on the snow.[1]

(**d**) How long are you coasting on the ice?

(**e**) How much speed do you pick up while you're on the ice?

You've picked up quite a bit of speed! But once you're back on the snow you're able to regain control and gradually slow down before you reach the bottom of the hill.

[1] I've never been snowboarding in my life, don't take this as advice for what to do if you hit a patch of ice!