Flipping Physics Lecture Notes:

2017 #4 Free Response Question - AP Physics 1 - Exam Solution
http://www.flippingphysics.com/ap1-2017-frq4.html

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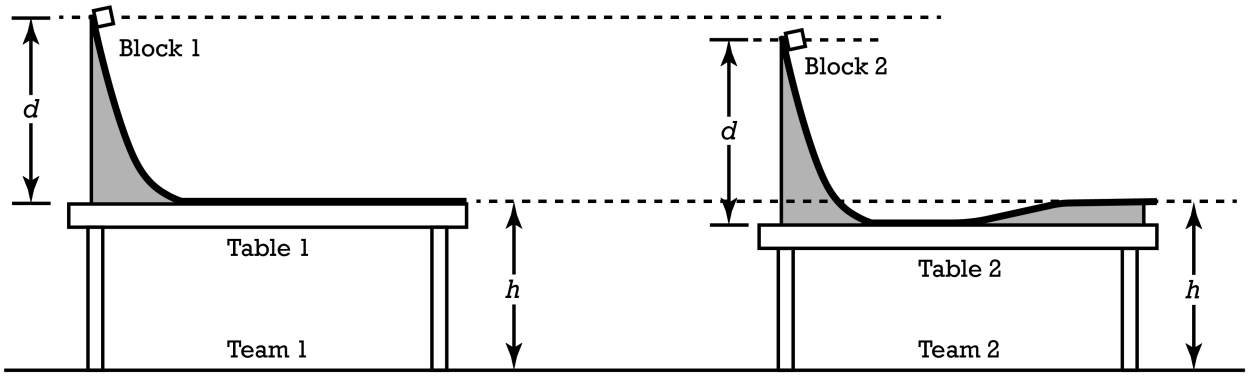


A physics class is asked to design a low-friction slide that will launch a block horizontally from the top of a lab table. Teams 1 and 2 assemble the slides shown above and use identical blocks 1 and 2, respectively. Both slides start at the same height d above the tabletop. However, team 2's table is lower than team 1's table. To compensate for the lower table, team 2 constructs the right end of the slide to rise above the tabletop so that the block leaves the slide horizontally at the same height h above the floor as does team 1's block (see figure above).

(a) Both blocks are released from rest at the top of their respective slides. Do block 1 and block 2 land the same distance from their respective tables?

___ Yes _X_ No Justify your answer.

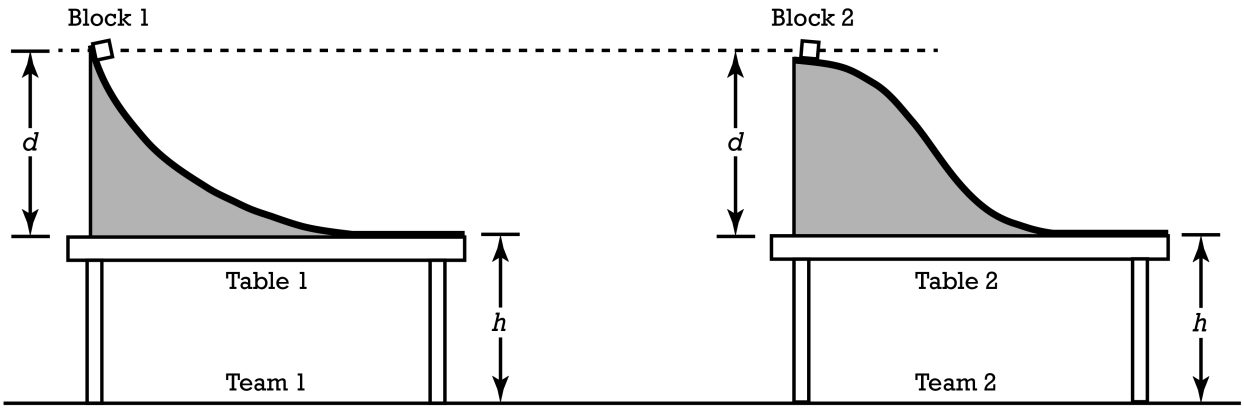
Because both slides are "low-friction", we may assume friction is negligible, therefore, there is no external work done on the system and mechanical energy is conserved. In both cases gravitational potential energy is converted to kinetic energy, however, Team 1's ramp has a larger change in gravitational potential energy because block 1 has a higher initial height above the end of the ramp. Therefore, block 1 has more kinetic energy when leaving the ramp and therefore a larger velocity in the x-direction. Because both blocks have an initial velocity off the table in the y-direction of zero, the same initial height, and the same free fall acceleration, both blocks will have the same amount of time between leaving the ramp and striking the ground. Considering they have the same time off the ramp and block 1 has a larger velocity in the x-direction, block 1 will land farther from the table than block 2. So "No", both blocks do not land the same distance from their respective tables.

Notes about grading: This problem is worth 3 points. 1 point is awarded for each of the following.

1) *"Attempting to use conservation of energy to compare the two blocks."*
    a. *Realize the word "attempt" is in there. So as long as you try to use conservation of energy, you gain 1 point.*
2) *"Explicitly or implicitly indicating that the launch velocities are different."*
    a. *Realize you do not even need to correctly identify which block has the larger launch velocity to get this point.*
3) *"Stating or implying that the time to reach the ground is the same for both blocks."*
    a. *I will be honest, when I initially did this problem, I did not mention this. So, be careful of the assumptions you are making.*

Considering "if the wrong answer is selected, partial credit can be earned for the justification" and you can get a lot wrong and still gain 2 points for this problem. Please answer every part of every problem.

In another experiment, teams 1 and 2 use tables and low-friction slides with the same height. However, the two slides have different shapes, as shown below.



(b) Both blocks are released from rest at the top of their respective slides at the same time.

i. Which block, if either, lands farther from its respective table?

____ Block 1 ____ Block 2 __X__ The two blocks land the same distance from their respective tables.
Briefly explain your reasoning without manipulating equations.

*Again, mechanical energy is conserved for both blocks. Change in gravitational potential energy is the same for both blocks, so both blocks have the same kinetic energy at the base of the ramp, and therefore the same velocity in the x-direction off the table. Again, both blocks have the same velocity of zero in the y-direction off the table, the same initial height, and the same free fall acceleration, so both blocks have the same change in time in projectile motion. Because both blocks have the same velocity in the x-direction and the same change in time off the table, both blocks will have the **same** displacement in the x-direction off the table.*

ii. Which block, if either, hits the floor first?

__X__ Block 1 ____ Block 2 ____ The two blocks hit the floor at the same time.
Briefly explain your reasoning without manipulating equations.

*While the change in time off the table and the velocity in the x-direction may be the same for both blocks, block 1 has a steeper ramp which will result in a larger acceleration for block 1 and therefore block 1 takes less time to get to the same velocity in the x-direction at the end of the ramp. Therefore, **block 1** will spend less time on the ramp and hit the floor first.*

Note about grading: It is easy to fall into the trap of rushing quickly through this problem and saying to yourself, "I remember seeing the video from Flipping Physics about this and in that video both objects hit the ground at the same time. So, that must be the answer." I mean, this is a classic physics example. However, it is typical on AP exams to see problems that expand on "typical" problems you have already seen. In other words, read carefully and apply your knowledge. Do not simply assume the problem is the same as one you have seen before.