P121 Exam 2 Summary Session

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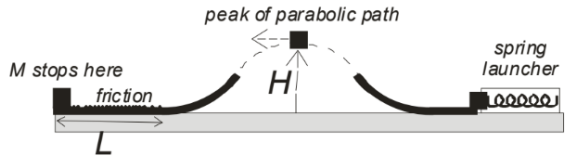
1 Learning Objectives

By the end of this session, students will be able to:

- Do a little jig
- Apply CofME to problems involving multiple potential energies
- Express position, velocity, etc. using Unit Vectors
- Apply CofLM to different kinds of 1D collisions
- Call Corbin Covault "Bestie"

2 Question 1

(30 *pts*) A horizontal spring of spring constant k is compressed by a distance x to launch a block of mass M along a frictionless track that ends with an upward ramp, as shown in the figure. The block then follows a parabolic projectile path that reaches a maximum height H above the launch point. The projectile path carries the block to an exit ramp that is a mirror image of the launch ramp, except that the exit ramp ends with a horizontal section of track with significant kinetic friction, described by μ_k, rather than with a spring. Friction brings the block to a stop over a distance L.

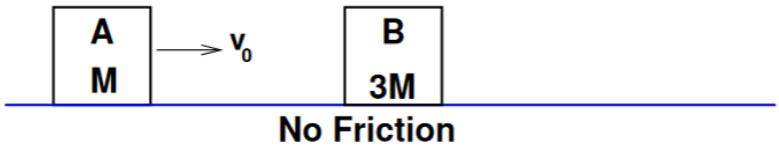


A. How much work is done by the normal force from the track during the launch and landing phases of this motion? Justify your response; this should take only a few words.

B. How fast, v_p, is the mass traveling at the peak of its projectile path? You should answer this question in terms of k, x, M, H, and g, although you might not need all of these parameters. *Note that you are NOT given the angle θ at which the mass is launched into the air. This is not a mistake; you don't need θ to answer this question.*

C. What is the minimum length L of horizontal track at the end that is required to bring the mass to a stop? You should answer this question in terms of k, x, M, μ_k, and g, although you might not need all of these parameters. Note that you are NOT allowed to use H in your answer.

3 Question 2



2 blocks are placed on a frictionless surface (see figure). Block A has a mass $m_A = M$, and Block B has a mass $m_B = 3M$ (M is given). Block A has a known initial velocity $v_A = v_0$ to the right, while Block B is initially at rest.

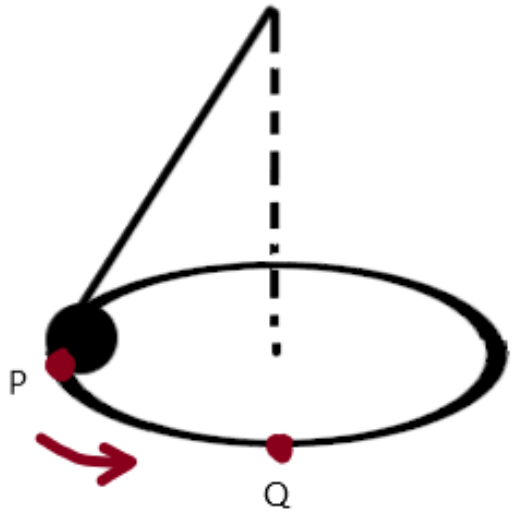
Part (a): First, let's say that the collision between the blocks is Totally Inelastic. Find the final velocity of each block.

Part (b): Now, let's say that the collision is Totally Elastic. Find the final velocity of each block.

Part (c):*Now,* let's say that the collision isn't Totally Elastic or Totally Inelastic, but somewhere in between. You're also told that the final velocity of Block A is 0. Find the final velocity of Block B.

Part (d): Let's change the problem one more time. Let's say that at time $t = 0$ we apply a constant applied force, F_{app} in the rightward direction to Block B. As a function of time, determine the velocity of the center of mass of the system of the two blocks. *Hint: For part d, is the system isolated?*

4 Question 3



A pendulum causes a bob to move in an elliptical orbit. The bob's position as a function of time can be described by the following vector equation:

$\vec{r}(t) = 3Acos(\omega t)\hat{i} + 2Asin(\omega t)\hat{j}$

Where A and ω are given positive parameters and $\hat{i}$ and $\hat{j}$ are standard Cartesian unit vectors.

Part (a): Point P corresponds to the position of the bob at time t=0. What is the speed of the bob at point P?

Part (b): Write down a *vector expression* that gives the *net force* on the bob when it is at point P in terms of the given parameters and the unit vectors as indicated.

Part (c): Point Q corresponds to the position of the bob at time $t = \frac{\pi}{2\omega}$. What is the **radius of curvature** when the bob is at point Q as shown?

Useful facts: sin(0)=0, cos(0)=1, sin($\frac{\pi}{2}$)=1, cos($\frac{\pi}{2}$)=0.

5 Notes

- Don't panic. You will do great!
- Professor Mafu will be holding an "extra help" session on March 21, 2024 from 3:00 p.m. to 4:30 p.m in his office (Rock 124).
- In place of a regular SI Session, MG will be holding "office hours" tomorrow from 5:30 to 7p.m. in Bingham 140. Please stop by if you have questions!