UNIVERSITY OF CALIFORNIA AT BERKELEY

Physics 7A - Lecture 2 (Stahler)

Fall 2018

FIRST MIDTERM

Please do all your work in this exam, in the blank spaces provided. If you have your solutions on scratch paper, **staple it to the last page.** Do not insert it in the exam.

You must attempt all four problems. If you become stuck on one, go on to another and return to the first one later. Be sure to show all your reasoning, since partial credit will be allotted. No credit will be given for unjustified answers. **Remember to circle your final answer.**

Name: ______________________ Signature: ______________________

SID: ______________________ Section: ______________________

Problem 1 (15 points)

The velocity of a particle as a function of time t is

$$\mathbf{V}(t) = \left(\alpha\, t^2 \,,\, \beta\, t \,,\, \gamma\, \mathrm{e}^{t/t_0}\right) \,,$$

where α, β, γ, and t_0 are all positive constants.

(a) What is the particle's acceleration, $\mathbf{a}(t)$?

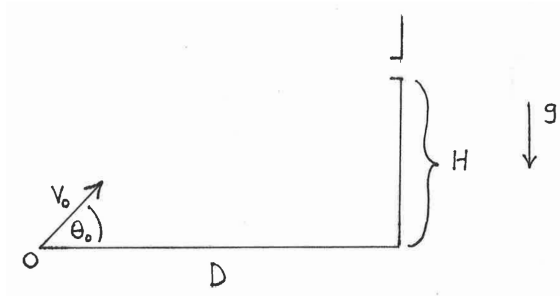
At $t = 0$, the particle is at $x = 1$, $y = 0$, and $z = -3$.

(b) What is $\mathbf{r}(t)$, the particle's position as a function of time?

End of Problem 1 workspace.

Problem 2 (30 points)

A ball is launched at point O, which lies a distance D from a vertical wall. The initial speed of the ball is V_0, and the initial launch angle is θ_0, as shown. Embedded in the vertical wall is a small pipe, located a height H above the ground. In order for the ball to enter the pipe, its velocity must be in the horizontal direction. Your task will be to find the initial angle θ_0 such that the ball enters the pipe. Proceed in the following steps:



(a) Find an expression for $V_{0\mathrm{y}}$, the initial vertical speed, in terms of g and H.

(b) Next find a second expression for $V_{0\mathrm{y}}$ in terms of g, D, and $V_{0\mathrm{x}}$, the initial horizontal speed. (*Hint:* Consider the time for the ball to reach the wall.)

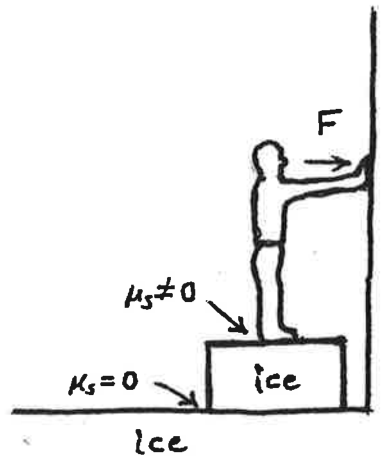
(c) Combining your answers for (a) and (b), find $V_{0\mathrm{x}}$ in terms of g, D, and H.

(d) Based on your answers for (a) and (c), find θ_0 in terms of D and H.

You may continue your work on the next page.

End of Problem 2 workspace.

Problem 3 (30 points)



A man of mass M_1 is standing on a block of ice of mass M_2. The block rests on a flat surface, also made of ice. There is no friction between the block and flat surface. However, there is a non-zero coefficient of static friction, μ_s, between the man's shoes and the block he is standing on. The man now pushes against the vertical wall shown with a horizontal force of magnitude F.

(a) Assuming provisionally that the man does not slip relative to the block, draw a free-body diagram for him, carefully labeling all the forces, **in the blank space below**.

(b) Under the same assumption, draw a free-body diagram for the block, **in the blank space below**.

(c) Still assuming the man does not slip, what is the magnitude and direction of **a**, his vector acceleration? Your answer for the magnitude should depend only on M_1, M_2, and F.

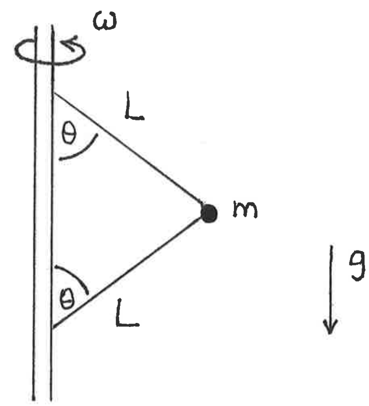
(d) What is F_{max}, the maximum force the man can apply before he *does* slip?

You may continue your work on the next page.

End of Problem 3 workspace.

Problem 4 (25 points)

A small mass m is attached to a revolving vertical pole by two massless strings of length L, each making an angle θ with the pole. Both the pole and the mass are rotating with angular speed ω.



(a) **In the blank space below**, draw a clearly labeled free-body diagram for the mass m. Be sure to include T_1 and T_2, the tensions in the upper and lower strings, respectively.

(b) Find expressions for T_1 and T_2 in terms of L, ω, θ and g.

You may continue your work on the next page.

End of Problem 4 workspace.