Exam 1; Phys 185 Name _____

Note: As I walk around, you can ask me for help; for example, to supply an equation or a number you have forgotten down, or to give you algebra aid. If you do, however, I will write down what help I provided on your exam, and grade your answer accordingly. It costs nothing to have me check and tell you if your answer on a question is correct or not.

1. (30 points) A person with compromised pinch strength in their fingers can only exert a normal force of magnitude n to either side of a pinch-held object. Find an equation for $m_{\max}$, the mass of the heaviest book this person can hold onto vertically before it slips out of his or her fingers, in terms of n, g, and μ_s.

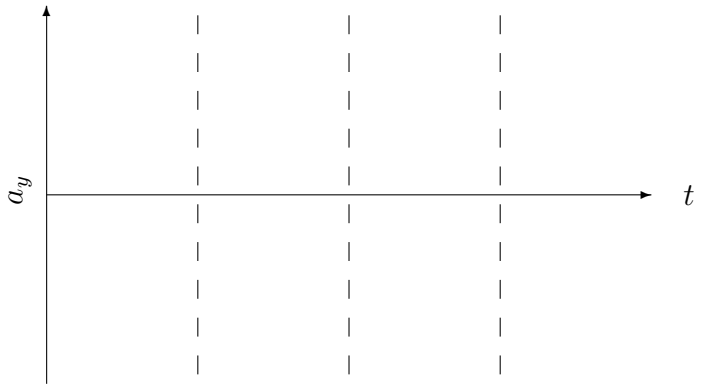
2. (50 points) Make qualitative sketches of the acceleration, velocity and position for the three following descriptions of a falling object. All three have the same initial position y_i.

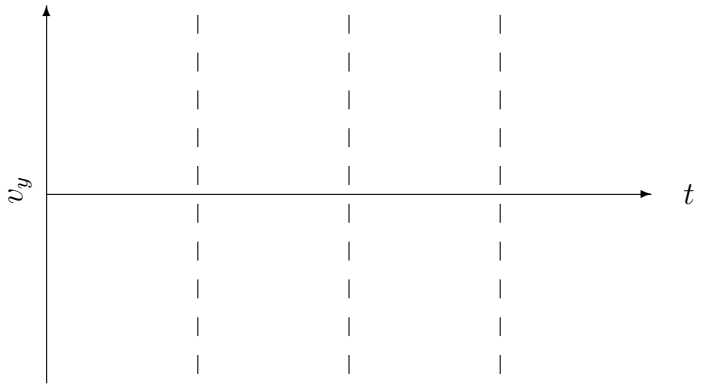
(a) Solid line: The object has only gravity acting on it. It starts at rest: $v_{iy} = 0$.

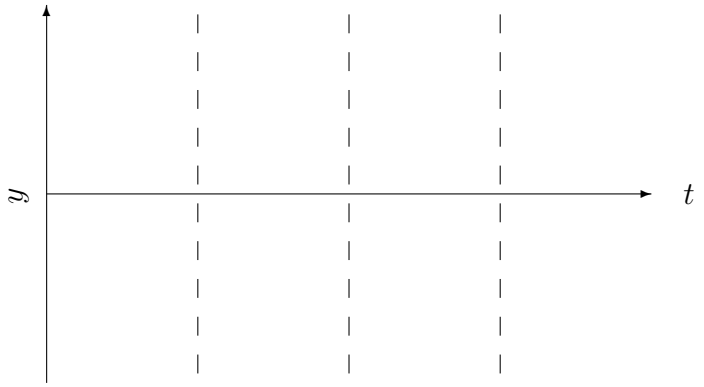
(b) Dotted line: The object has gravity plus a significant drag force acting on it. $v_{iy} = 0$.

(c) Dashed line: The object moves straight down with a *constant* speed equal to v_T, the terminal speed in the presence of gravity and air resistance. $v_{iy} = v_T$.

The exact shapes of the curves are not important, but be clear about straight lines and points of intersection. *In the space next to each graph, explain your reasoning.*







3. (40 points) You launch a projectile on a level surface on a planet with acceleration due to gravity g, starting from $x_i = y_i = 0$, with initial speed v_i and angle θ with the x-axis. But you're facing a strong horizontal wind, so that the motion has a non-zero $a_x = -w$, where w is a positive constant that stands for the magnitude of the acceleration due to the wind.

(a) Write down the equations for motion along the x and y-axes:

$v_{fx} =$ $\qquad\qquad$ $x_f =$

$v_{fy} =$ $\qquad\qquad$ $y_f =$

(b) Find the *range* of the projectile: an equation for how far it will travel until it hits the ground again.

(c) Check your result: when you set $w = 0$, you should get the same equation for the range as you have in your class notes.

(d) The range is positive when $w <$ [an expression involving g and θ]. Find this inequality. Would it make physical sense for the range to be negative?

(e) See what happens when $w = g$ and $\theta = 45°$. Interpret your result in this case—what does the motion look like?

4. (40 points) An adult falls from a height h, and then strikes a pad with thickness d. Model the the person's contact with the pad as motion with constant acceleration that brings her to a complete stop after traveling a distance d. Say that damage to the body becomes probable when its stopping acceleration exceeds $10g$.

(a) What is the minimum ratio d/h for safety?

(b) For a three story height, $h \approx 10$ m. About what thickness of landing pad would be needed? Is this a reasonable number?

5. (40 points) In Lab 3, "Acceleration due to Gravity," you made a number of simplifying assumptions. In the list below, describe how neglecting each effect made you slightly underestimate or overestimate g as calculated from your data. (I include the answer for the first as an example.) Also draw and label arrows for *every* force you know of on the diagram, including those that you neglected as being too small to worry about, and including forces on the string and pulley.

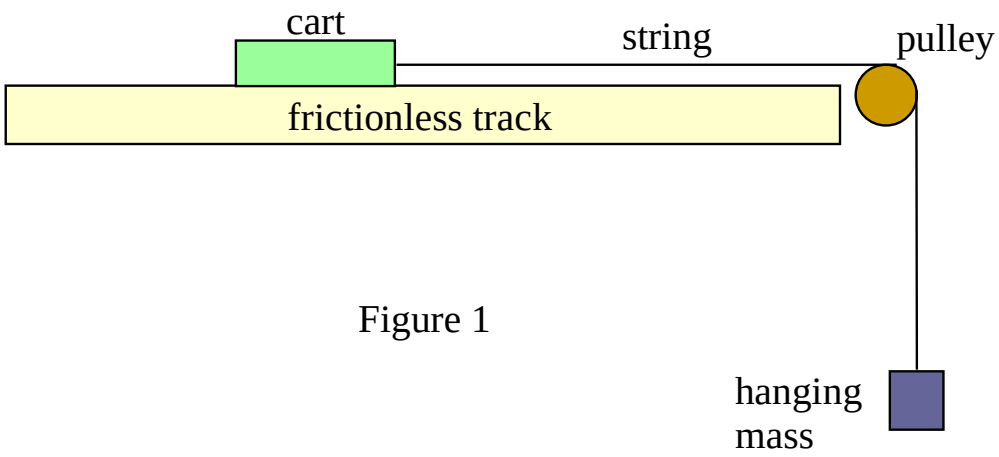


Figure 1

(a) **Track not frictionless:** A small extra kinetic friction force on the cart toward the left slows the cart down, increasing the measured Δt. The equation for g was

$$g = \frac{2(m_{\text{hanging}} + m_{\text{cart}})\Delta x}{m_{\text{hanging}}\,(\Delta t)^2}$$

With increased Δt, friction will cause us to underestimate g.

(b) **Drag on the cart:**

(c) **Track not exactly level; cart goes slightly downhill:**

(d) **Drag on hanging mass:**

(e) **Initial speed of cart into first photogate not quite zero:**

(f) **Pulley not frictionless:**

(g) **Pulley not massless:** (This one is complicated; do your best. Bonus +5 points.)