
FIRST EXAM - PHYSICS C1401X

PROFESSOR SCIULLI

SEPTEMBER 29, 2003

ATTENTION:

- 1. Read this FRONT page while waiting for the exam to begin. Do NOT open either this exam book or the blue book until you have been given permission by the proctor.**
- 2. The proctor will write the remaining time on the board at intervals throughout the exam.**
- 3. If you have a question during the exam, quietly ask one of the proctors.**
- 4. When you are told to stop the exam, you MUST immediately put down your pen(cil) and close BOTH the exam and your blue book. Then return your exam to one of the proctors. Include your signed handwritten supplementary page.**
- 5. When you turn in your exam, you must show your Columbia ID to the proctor.**

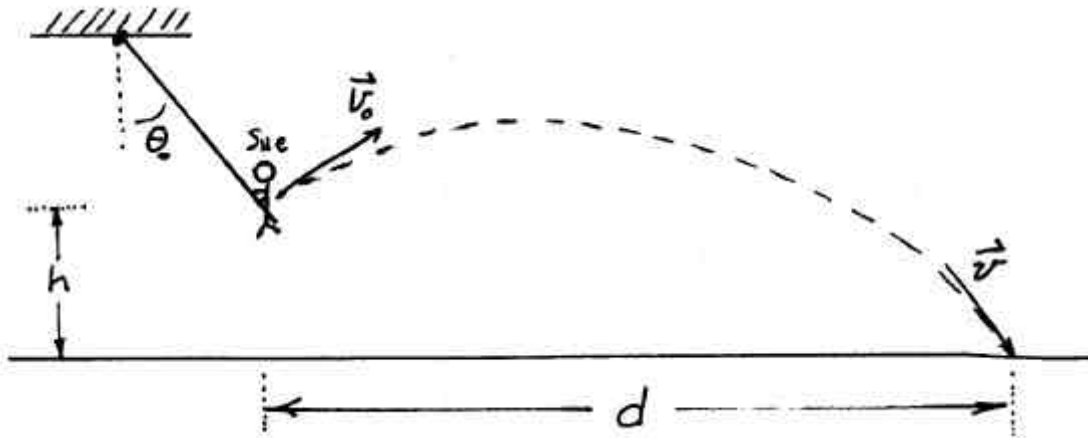
Please write your name, first name followed by last, on BOTH the front and back covers of your blue book(s).

Further Instructions: There are three problems to be answered in the blue book. Make sure your name is clearly written on both the front and back pages of each blue book and which problem answers are inside that book. Note that the **first** problem is worth slightly **less** than the others. Give numerical answers with units when appropriate. In order to obtain partial credit, be sure to make clear your reasoning. It is **strongly** suggested that you read through the exam and answer **first** the questions you consider easier. Indicate by roman numeral in the blue book which question you are answering and by arabic numeral which part. Start each new problem (of the three) on a new page in your blue book. You may use a calculator and a supplementary page, written by you, on one side of an 8 1/2" × 11" paper. No other notes or books are allowed.

Do not turn the page until the proctor has told you to begin!

- **Generally usable constant** $g = 9.8 \text{ m/s}^2$
- **Life is simpler if you make sure you are using standard units: meters, seconds, etc. ... when you evaluate numbers. Be sure to indicate the units of all numerical answers.**
- **In all figures, up is the direction toward the top of the page, and horizontal is the direction left to right.**
- **Air resistance is negligible in the following questions.**

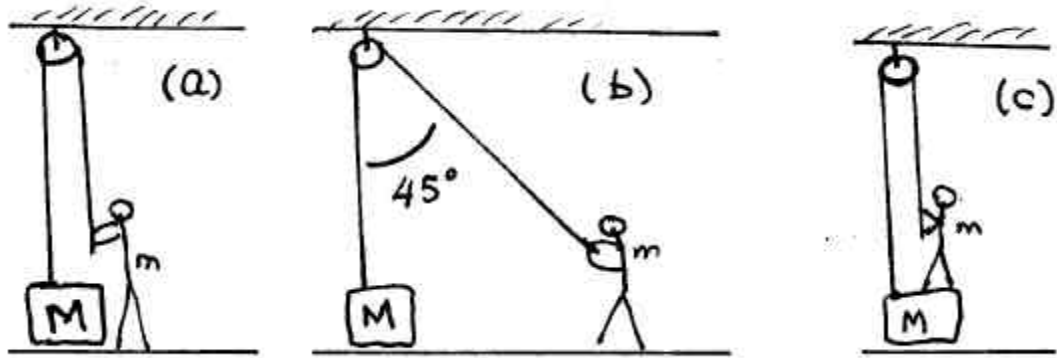
Problem I – 30 points



The figure shows Sue, swinging on the end of rope at the instant she releases her hold on the rope. At this instant, when she is at a height $h=0.5\text{m}$ above the ground, she lets go. Her friend starts his watch at the instant she releases from the rope. She subsequently travels a horizontal distance $d=3.0\text{m}$ over a time $t=1.7\text{s}$ before hitting the ground.

1. Find the horizontal and vertical components of her velocity when she lets go of the rope.
2. Find the horizontal and vertical components of her velocity when she hits the ground.
3. What is the angle (θ_0 on the figure) that the rope makes with the vertical when she lets go?
4. Find the horizontal and vertical positions of Sue relative to her starting point when she reaches her maximum height.

Problem II – 35 points



The three figures above show Alex exerting just enough force to lift a package by pulling on the rope in a pulley system (attached at the ceiling) under three different circumstances:

(Fig a) He is on the ground next to the package.

(Fig b) He is on the ground at a horizontal distance from the package that equals the vertical distance between the package and the pulley.

(Fig c) He is under the pulley again, but standing on top of the package. In all cases, Alex has a mass **150 kg** and the package has a mass **60 kg**.

For figure (a) on the left,

1. Find the magnitude of the force he exerts on the pulley rope.

For figure (b), in the middle,

2. Find the magnitude of the force he exerts on the pulley rope.
3. Make a sketch of all the forces on Alex and find the horizontal and vertical components of the force exerted by the floor on Alex.
4. What must be the coefficient of static friction between Alex and the floor so that he does not slip?

For figure (c), on the right,

5. Find the magnitude of the force he exerts on the pulley rope.
6. Find the direction and magnitude of the force exerted by the package on the man.



Problem III – 35 points



The figure shows a wintry scene after a snowfall. Maria sits on a sled near the top of a slope with an angle of $\theta=25$ degrees to the horizontal. She and the sled have a total mass of **50 kg**; between the sled and the snowy ground is a coefficient of static friction, $m_s=0.80$, and coefficient of kinetic friction, $m_k=0.10$. Once she starts to move, she slides a distance of **d=100m** to the bottom of the slope. Her friend Ari must give her a push to get her started. He starts his clock at exactly the same time.

1. Make a clear force diagram showing all the external forces on the system, consisting of Maria and the sled, before she is pushed.
2. Find the friction force being exerted on the sled before she is pushed.
3. Find the force that Ari must momentarily apply in order to get Maria started. Assume that he exerts this force and no more.
4. Find the time on the clock when she reaches the bottom of the slope and her speed at the same time.
5. Find the clock's time when she subsequently stops along the level ground.

*****End of Exam*****