FIRST EXAM SAMPLE - PHYSICS C1401X

PROFESSOR SCIULLI **FALL 2003**

ATTENTION:

1. **Do NOT open either this exam book or the blue book until you have been given permission by the proctor.**
2. **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.**
3. **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 **last** 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 $8\ 1/2" \times 11"$ paper. No other notes or books are allowed.

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

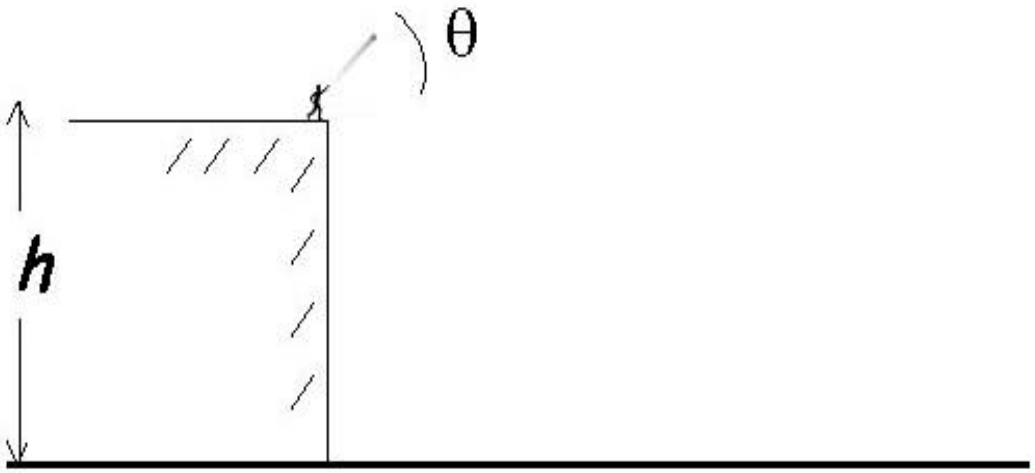
Generally usable constant $g = 9.8\ m/s^2$

Hint: 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 such answers.

Mathematical solution to $ax^2+bx+c=0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Problem I – 35 points



The figure shows a man throwing a rock from the roof of a building. The rock has a mass of ***0.5 kg***. When it leaves his hand, the rock has a speed equal to ***10 m/s*** and an angle relative to horizontal of q ***=40 degrees***. The man's arm is located a height ***h = 100 meters*** above the ground. Neglect air resistance in answering the following.

1. Find the initial horizontal and vertical components of the rock's velocity.
2. How high above the ground does the rock go <u>after</u> it leaves his hand? In other words, what is its maximum vertical distance from the ground?
3. How long is the rock in the air?
4. Find the vector velocity components of the rock just as it <u>hits the ground</u>.
5. In throwing the rock, the <u>man's arm</u> traveled ***1.2*** meters. What was the average acceleration (magnitude and direction) of the rock <u>while he threw it</u>? What was the average force (magnitude and direction) exerted by the man on the rock while the man was throwing it?

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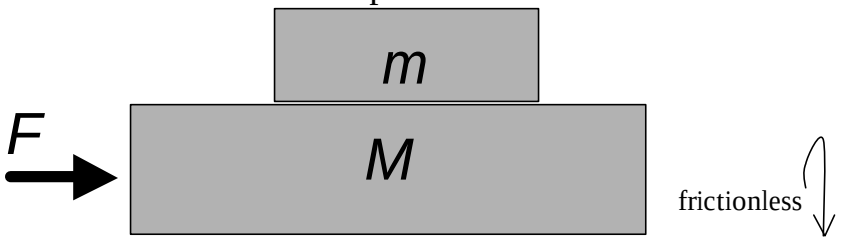
Problem II – 35 points



m=3 kg
M=10 kg

The slab ***M*** lies on top of a frictionless surface. A block of mass ***m*** is placed on top of it. For several circumstances of the surface between ***M*** and ***m***, you are asked for the subsequent motion when a constant force ***F= 50 N*** pushes on ***M*** as shown. Find answers (with appropriate units) for the following.

1. For ***m*** and ***M*** stuck together, find the acceleration of the masses.
2. Suppose the surface between ***m*** and ***M*** is rough, with coefficient of static friction, m_s. Draw individual diagrams showing all the forces on ***m*** and ***M***. Label all forces and describe in words what each label represents.
3. What values for m_s will have the two masses traveling together as in part (1)?
4. Suppose the two masses can slide on each other, but there is kinetic friction between them. Find the coefficient of kinetic friction, m_k, for which ***m*** accelerates at half the acceleration of ***M***. Also find the acceleration of ***M***.

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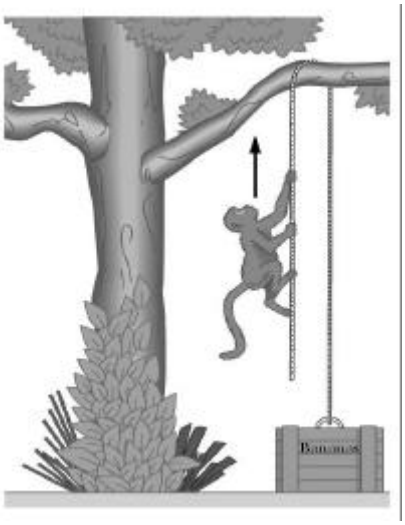
Problem III – 30 points

Read carefully!



The monkey in the figure to the right is accelerating up a rope, which passes over a frictionless tree branch and attaches to a package of bananas. At the moment shown (t=0), the package is just lifting off the ground with an acceleration (relative to the ground) equal to 1.0 m/s^2. The **monkey** has a mass equal to **8 kilograms**, and the mass of the **package** is **10 kilograms**.

1. Find the tension in the rope.
2. Find the net force on the monkey. Find his acceleration.
3. Calculate how far the monkey travels up in 0.5 seconds.
4. After the 0.5 seconds, the monkey stops climbing and just holds on. How much higher is the monkey (than when he started at t=0) when the package hits the ground?

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