Honors Physics – P221

Exam I

Distributed on Friday, September 27, 2002
and due at 1:25 pm on Monday, September 30, 2002

Guidelines:

(1) This exam consists of five questions, each worth 10 points, and two problems, each worth 25 points. Please show all your work in the blue books provided.

(2) You can use your text, notes and computer – but you may not consult with anyone while taking this exam.

(3) If you have a question about any of these problems please send me an e-mail. I will try to respond as quickly as possible – I will be visiting Cornell U Thursday afternoon through early Sunday.

(4) Please take the time to write your solutions neatly and clearly. Be sure to specify units.

Thank you,

Alex R. Dzierba

Please print your name below and also sign your name. By so doing you are stating your understanding of the rules under which this exam is given and that you followed these rules.

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Part I (5 Questions – each worth 10 points)

Question 1 (10 points)

A 50 kg mass falls from rest from a height of 1 km above the Earth's surface and hits the ground well after the mass has reached a terminal velocity of 30 m/s. Assuming that the acceleration of gravity can be treated as a constant equal to 10 m/s^2, how much energy is lost (in joules) to air resistance?

Question 2 (10 points)

Three objects, a cube, a sphere and a cylinder each have the same volume V. The diameter of the cylinder equals its height. Find the numerical ratio of the surface areas:

Area [cube] : Area [sphere] : Area [cylinder]

Question 3 (10 points)

Two vectors, **A** and **B**, lie in the x-y plane. Consider the following vectors:

$$\mathbf{C} = 2\mathbf{A} + 3\mathbf{B}$$

$$\mathbf{D} = \mathbf{A} \times \mathbf{C}$$

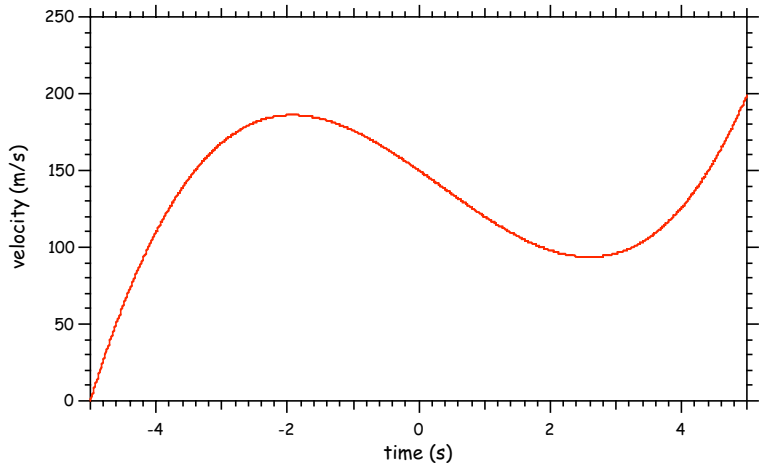
A new (primed) coordinate system is rotated with respect to the original (unprimed) by a rotation about the z-axis of the original coordinate system so that the new x' axis makes an angle of $+30^{o}$ with respect to the original x axis. What are the coordinates of **C** and **D** in the primed system expressed in terms of their coordinates in the unprimed system?

Question 4 (10 points)

The plot below shows the dependence of velocity on time for a certain object constrained to move along the x-axis.

(a) What is the numerical value of acceleration at t=0?

(b) What is a distance traveled by the object from t = 0 to t = 2 s? Give a number.



Question 5 (10 points)

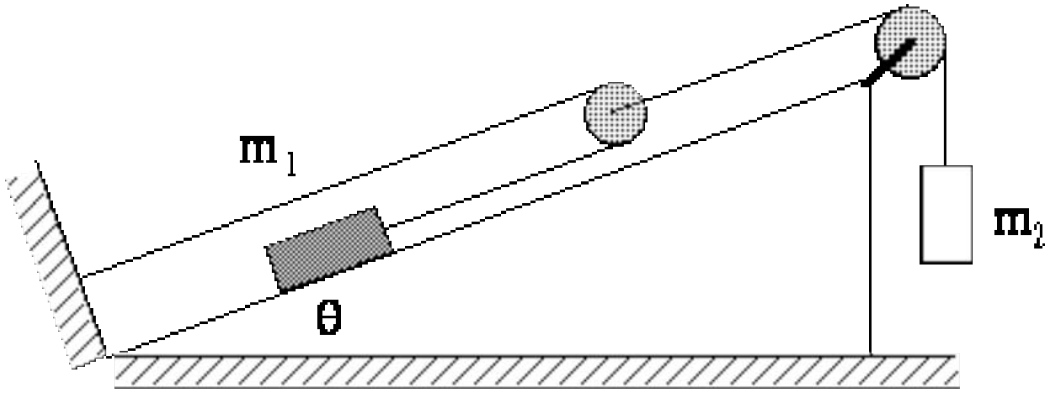
With what speed must a ball be thrown directly upward in the Earth's gravitational field so that is remains in the air for a total of 10 s? How high does the ball rise?

Part II (2 Problems – each worth 25 points)

Problem 1 (25 points)

In the figure below the mass on the ramp slides without friction. The strings are massless as are the frictionless pulleys. Find the:

(a) acceleration of m_1
(b) tensions in the two strings.



Problem 2 (25 points)

The figure below shows a block of mass M attached to a string of length r. Sitting on top of this block is another block of mass m. The coefficient of static friction between the two blocks is μ_s. The coefficient of kinetic friction between the mass M and the surface on which it moves is μ_k. The dimensions of the blocks are negligible compared to r. The string has a breaking tension of T_o. The blocks are given an initial tangential speed of v_o. Find the following:

(a) The maximum value of v_o consistent with the blocks staying together and moving in a circle.
(b) The time required to bring the masses to rest.
(c) The total number of revolutions of the masses before they come to rest.