February 21, 2007 Physics 207

EXAM 1

Please print your name and section number (or TA's name) clearly on all pages. Show all your work in the space immediately below each problem. **Your final answer must be placed in the boxes provided**. Problems will be graded on reasoning and intermediate steps as well as on the final answer. Be sure to include units wherever necessary, and the direction of vectors. **Each problem is worth 20 points**. Try to be neat! Check your answers to see that they have the correct dimensions (units) and are the right order of magnitude. You are allowed one sheet of notes (8.5" x 11", 2 sides), a calculator, and the constants in this exam booklet. The exam lasts exactly 90 minutes.

Constants:

Acceleration due to gravity at the earth's surface: $g = 9.81$ m/s^2

Avogadro's Number: $N_A = 6.02 \times 10^{23}$ molecules/mole

1 metric ton = 1000 kg

Radius of the Earth = 6.4×10^6 m

(Do not write below)

SCORE:

Problem 1: _____

Problem 2: _____

Problem 3: _____

Problem 4: _____

Problem 5:_____

TOTAL: _____

Don't open the exam until you are instructed to start.

Please *relax and think calmly*.

PROBLEM 1

Suppose a one-dimensional motion of an object of mass m is found to have its acceleration given by $a(t)=bt$ where b is a constant.

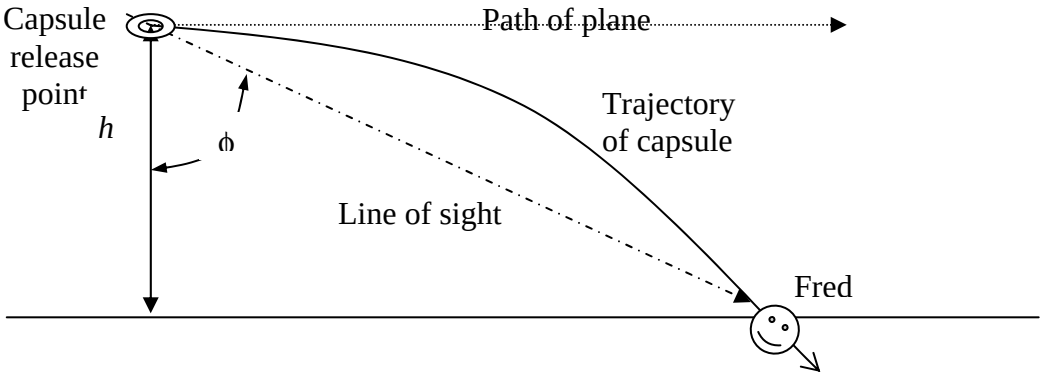
a) What is the velocity $v(t)$ if initially at $t=0$, we have $v(0)=0$? (*7 pts.*)

b) What is the position $x(t)$ if initially at $t=0$, we have $x(0)=x_0$? If you cannot write anything for part a), express your answer in terms of an expression involving $v(t)$ and other constants. (*8 pts.*)

c) What is the net force acting on this particle? (*5 pts.*)

PROBLEM 2

A rescue plane flies at 198 km/h (= 55 m/s) and a constant elevation of 500 m toward a point directly over Fred, a boating accident victim struggling in the water. The pilot wants to release a life ring so that it hits the water very close to the victim as shown below. Neglect air resistance.



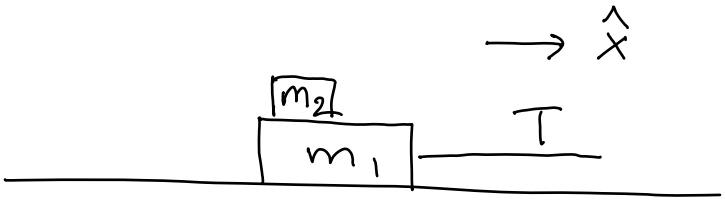
a.) How long will it take for the ring to reach Fred after it is released? (*6 pts*.)

b.) What should be the angle, ϕ, of the pilot's line of sight to the victim when the release is made? (*7 pts*.)

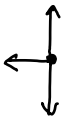
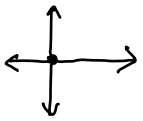
c.) With what speed (magnitude) will the ring hit the water? (*7 pts*.)

PROBLEM 3

(multiple choice: circle the correct answer) A block with mass m_1 (which we call block 1) is pulled by a rope with tension T along the ground as shown in the figure where the coefficient of kinetic friction between the ground and the block is μ_k. On top of this block is another block of mass m_2 (block 2) which is moving in the same direction as m_1 but sliding relative to m_1 in the opposite direction ($-\hat{x}$). The coefficient of kinetic friction between the two blocks is μ_k.



a) Which of the following can be the free body diagram for block 2? (*5 pts.*)

1)  2)  3)  4) 

b) What is the acceleration of block 2 in the horizontal direction ($\hat{x}$)? (*5 pts.*)

1) $\mu_k \frac{m_1}{m_2} g$ 2) $\mu_k g$ 3) $\left(\mu_k \frac{m_1}{m_2} + 1\right) g$ 4) $\frac{T}{m_1} + \left(\mu_k \frac{m_1}{m_2} + 1\right) g$

c) How many agents of frictional forces are acting on block 1 (i.e. how many surfaces of frictonal contact)? (*5 pts.*)

1) 0 2) 1 3) 2 4) 3

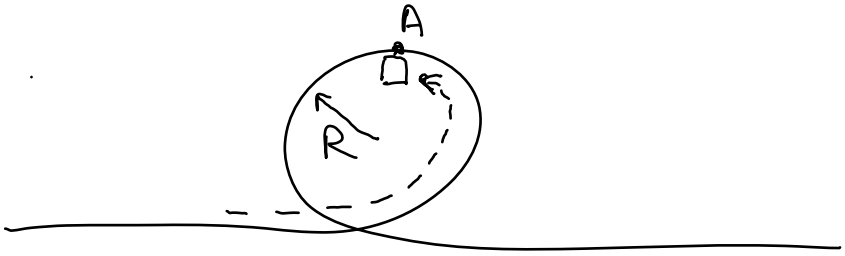
d) What is the acceleration of block 1 in the horizontal direction? (*5 pts*.)

1) $-2g\mu_k + \frac{T}{m_1}$ 2) $\frac{-m_2}{m_1}g\mu_k + \frac{T}{m_1}$ 3) $\frac{-2m_2}{m_1}g\mu_k + \frac{T}{m_1}$

4) $\frac{-2m_2}{m_1}g\mu_k + \frac{T}{m_1} - g\mu_k$

PROBLEM 4

A block with mass m is sliding on a frictionless loop ramp as shown in the figure.

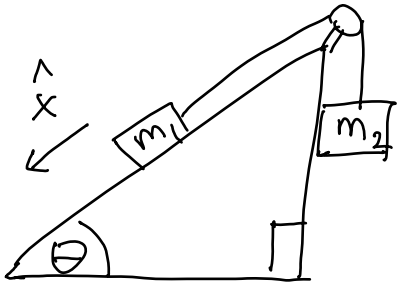


a) What is the minimum speed at point A in the figure that will result in the block not falling off at point A as it is traversing the top of the loop upside down? Assume that the radius of the approximately circular loop is R. (*15 pts.*)

b) What is the tangential acceleration at point A? (*5 pts.*)

PROBLEM 5

In the following figure containing an inclined plane and a pulley, the angle of the incline is θ and the coefficient of static friction between m_1 and the inclined plane is μ_s. Initially, all the masses are at rest and the angle θ is slowly increased starting from zero. At a critical angle $\theta=\theta_C$, m_1 accelerates in the positive $\hat{x}$ direction. Express μ_s in terms of θ_C, m_1 and m_2. (*20 pts.*)



(Extra space for work)