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PHY 105 Final Exam December 10, 2003 2 Hours

La Salle University
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Do all work in the blue book!

1. (**12%)** A small plane of mass 3000 kg is flying in air of density 1.0 kg/m^3. Air moves over the top and bottom surfaces of the wings at 160 m/s and 130 m/s, respectively.
   a) Calculate the minimum wing area needed to keep the plane from falling out of the sky
   b) If the plane flies too high, the density of the air starts dropping. When this occurs, the speeds in part (a) do not generate enough lift. If the density drops by a factor of 2, by what factor must the air-wing speeds increase in order for the plane to remain flying?

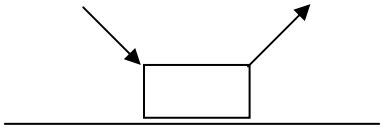
2. (**12%**) You are standing on a bathroom scale while at the equator. If your mass is 80kg, determine your apparent weight. The equatorial radius of the earth is 6.374 *x* 10^6 m. At the equator you are moving in a circle with average speed 464 m/s

3. (**14%**) One billiard ball, heading to the right at 10 m/s, collides with another billiard ball heading to the left at 5 m/s. (both billiard balls have the same mass)
   a) Calculate the final velocity of each block if an elastic collision occurs.
   b) Calculate the final velocity of both blocks if a totally inelastic collision occurs.

4. (**14%**) A bullet of mass *m* is shot straight up into the air moving at speed *v* where it hits a wooden block of mass *M*. The wooden block is attached to a spring suspended from the ceiling. The spring has spring constant *k*. The bullet sticks in the block. Describe in detail how you would find out how much the spring compresses. Use appropriate diagram(s) and equations(s) in your explanation, and be sure to list any assumptions that you make.

5. (**16%**) Buoyant forces can affect weight measurements. A mass of density ρ and volume V hangs from a very accurate force sensor. The apparatus is in air.
   a) Describe why air buoyancy causes the force sensor reading to display a value less than the object's true weight (defined as object's *mass* x *g*).
   b) Derive an expression for the percent error in the force sensor measurement with respect to the true weight. Your answer should be in terms of ρ and ρ_{air} only. Demonstrate that your expression has the correct units.
   c) Use your expression in (b) to determine the percent error when trying to "weigh" a hanging 1cm^3 wooden cube (ρ_{air}=1.21 kg/m3, ρ_{wood} = 700 kg/m3)

6. (**18%**) Two 25 N forces are applied to a 10 kg block as shown. Both forces lie in 45° directions
   a) Calculate the acceleration of the block assuming no friction. Use this acceleration to calculate the velocity of the block after it has gone 5.0 m.
   b) Calculate the acceleration of the block assuming a coefficient of kinetic friction of 0.22. Use this acceleration to calculate the velocity of the block after it has gone 5.0 m.



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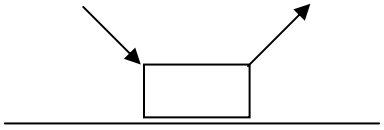
7. (**14%**) Using the same situation as problem 6,



   a) Assuming no friction, describe a system in which the Work-Energy theorem is valid. Use this theorem and system to find out how fast the block is moving after it has gone 5 meters. Compare this velocity to the result found in 6a.
   b) Assuming the friction of (6b), describe a system in which the conservation of Energy is valid. Use this theorem and system to determine $\Delta E_{internal}$ of the system and how fast the block is moving after it has gone 5 meters. Compare this velocity to the result found in 6b.