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# PHY 105 Final Exam December 17, 2004 2 Hours

La Salle University
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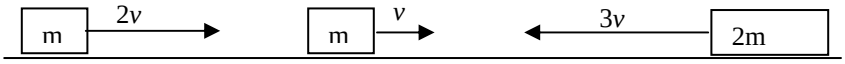
**Do all work in the blue book! When using conservation laws, you must identify the appropriate system!!**

1. (**10 pts)** A motorcyclist traveling at a constant speed of 90 mph passes a parked policeman, at which point the policeman begins chasing the speeder with an acceleration of 3 m/s$^2$
   a) How long will it take the policeman to reach the same *speed* of the car?
   b) What is the distance between the police car and the motorcycle at the time determined in (a)?
   c) If the police car keeps accelerating, when will the policeman catch the motorcyclist?

2. (**6 pts**) Using an appropriate free-body diagram, and identifying all forces, explain why your apparent weight at the equator is less than your true weight, where true weight is defined as *mg*.

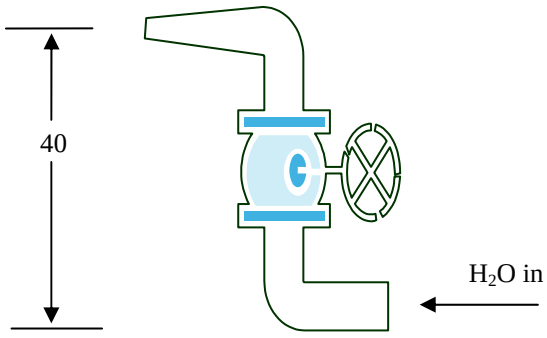
3. (**8 pts**) Three masses are moving on a frictionless table with speeds 2v, v, and 3v as shown. The cars are situated in such a way that there is a simultaneous 3-way crash.




   a) Calculate the final velocity of the combined mass in terms of *v* if a totally inelastic collision occurs. (Be sure to indicate the direction)
   b) Calculate the percentage of kinetic energy lost in the collision.

4. (**10 pts**) A 0.35 kg mass sits at the end of a horizontal spring that has been compressed. The spring has a spring constant of 400 N/m and has been compressed 4.5 cm. The mass is then released.
   a) Assuming a frictionless surface, how fast is the mass moving when the spring reaches its unstretched position?
   b) The mass and spring are now placed on a rough surface and the same experiment is repeated. This time the speed of the mass at the spring's equilibrium position is only ½ of that calculated for the frictionless surface in (a). Calculate the coefficient of kinetic friction between the brick and the table.

5. (**10 pts**) You are designing a plumbing system for a high-rise building. In the following diagram, the pipe diameter at ground level is 10 cm, the water pressure is 7.3 atm, and water is entering the pipe at a rate of 1.2 liter/s. The pipe enters a shower fixture 40 m above the ground.
   a) Calculate the speed of the water at the ground end of the pipe.
   b) Calculate the diameter of the shower fixture in order to have a water pressure of 3.4 atm (1 atm = 1.013 x 10$^5$ Pa)



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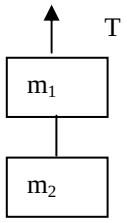
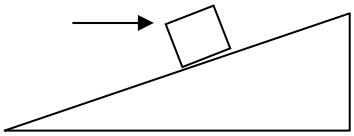
6. **(8 pts)** Two masses are pulled upwards by a tension as shown. They are accelerating upwards




   a) Calculate the acceleration of both blocks in terms of the masses, T and g.
   b) Calculate the tension in the line between mass 1 and 2 in terms of the masses and T.

7. (**6%**) An object of density $\rho_o$ and volume $V_o$ is observed to drop with acceleration *a* when submerged in a liquid of density $\rho_L$. Derive an expression for the density of the object in terms of the density of the liquid, *g*, and *a*.

8. (**12%**) A force of 25 N is applied to a 1.2 kg block on a 45° frictionless incline



   a) Calculate the acceleration of the block using Newton II. Use this acceleration to calculate the velocity of the block after it has gone 50.0 cm up the ramp.
   b) Describe a system in which mechanical energy is conserved. Use this system to find out how fast the block is moving after it has gone 50.0 cm. Compare this velocity to the result found in 8a.

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*Extra Credit problems are worth 6 pts each*

EC1

a) Calculate the acceleration of the block in #8 assuming a coefficient of kinetic friction of 0.22. Use this acceleration to calculate the velocity of the block after it has gone 50.0 cm up the ramp.

b) Describe an appropriate system and use conservation of energy to find out how fast the block is moving after it has gone 50.0 cm. Compare this velocity to the result found in part (a).

EC2

You are working on dunking a basketball from the foul line. If you jump from the foul line at an angle of 45°, what speed must you have in order to get your hand 10 inches above the rim at the highest point of your travel? (Assume that your hand is 7.5 feet above the ground when it is stretched vertically.) 1 inch = 2.54 cm