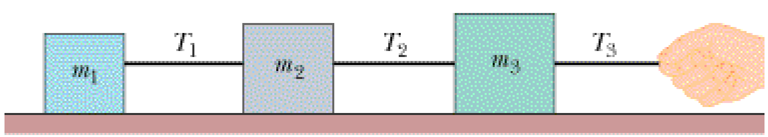
Final Test for PHYS 2130 section 091
Date: 2nd May 2007

Student First Name: Student Last Name:
Student Rocket ID:

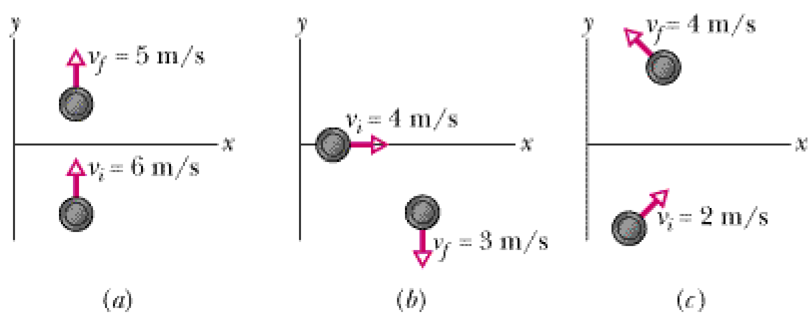
You may use the backside of all pages. No calculators are allowed. Express all answers only in terms of given quantities.

Questions 1: You are to drive to a job interview a distance d away from your home. You start driving T time units before the interview. Express all answers in terms of d and/or T or their functions. While going you speed and go at a speed of (2d)/T. While coming back you travel at half this speed. What is the average speed for the round trip home? (**2 points**)

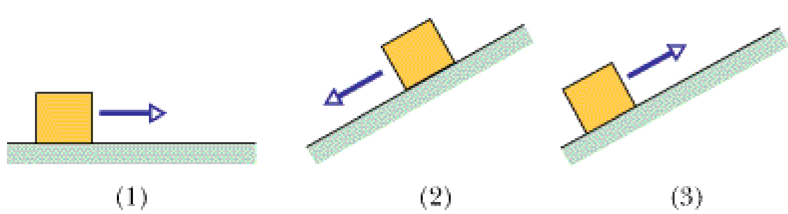
Question 2: In the figure, three connected blocks are pulled to the right on a horizontal frictionless table by a force of known magnitude F, depicted by the hand. The masses are attached to three massless cords as shown. The masses of three blocks m_1, m_2, and m_3 are known. The tensions in the three cords are T_1, T_2, and T_3 as shown. Calculate (a) the tension T_3, (b) the tension T_2, and (c) the tension T_1. (**3 points**)



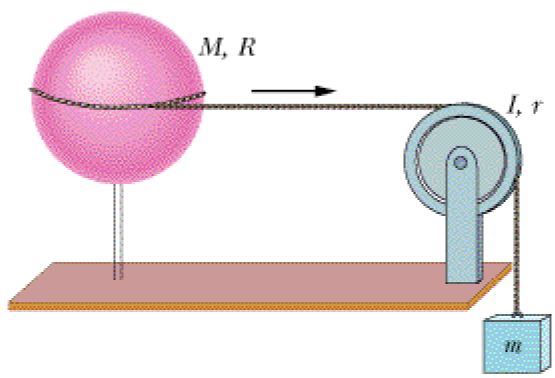
Questions 3: In three situations, a briefly applied horizontal force changes the velocity of a hockey puck that slides over frictionless ice. The overhead views shown in the figure indicate, for each situation, the puck's initial speed v_i, its final speed v_f, and the directions of the corresponding velocity vectors. It is given that the total mechanical energy of the puck remains constant throughout its motion and that the puck has an unknown form of potential energy. Rank the situations according to the change in potential energy of the puck, most positive first and most negative last. Explain your result with a simple numerical computation. (**1 point**)



Question 4: Figure below shows three situations involving a plane that is not frictionless and a block sliding along the plane. The block begins with the same speed in all three situations and slides until the kinetic frictional force has stopped it. Rank the situations according to the increase in thermal energy due to the sliding, greatest first. (**1 point**)



Question 5: A uniform spherical shell of mass *M* and radius *R* can rotate about a vertical axis on frictionless bearings as shown in the figure. A massless cord passes around the equator of the shell, over a pulley of rotational inertia *I* and radius *r*, and is attached to a small object of mass *m*. There is no friction on the pulley's axle; the cord does not slip on the pulley. What is the ratio of the angular speeds of the shell and the pulley as the object falls? If the angular speed of rotation of the pulley is ω_p then what is the linear speed of the object? (**3 points**)



Question 6: Suppose that you release a small ball from rest at a depth h below the surface in a pool of water. The density of the ball is a fraction f ($0 < f < 1$) that of water. The acceleration due to gravity has a magnitude g, the density of water is ρ_w, and the mass of the ball is m. Neglect the drag force on the ball from the water or air in this problem.
Answer all questions in terms of the known quantities m, g, f, h, and ρ_w only.
(a) What is the net force F on the ball when it is under water? (**1 point**)
(b) What is its speed v when it just starts emerging from the water? (**1 point**)

Question 7: The mass of the earth is M and its radius is R. A projectile launched directly away from the Earth's surface has mass m. The universal constant of gravitation is G.

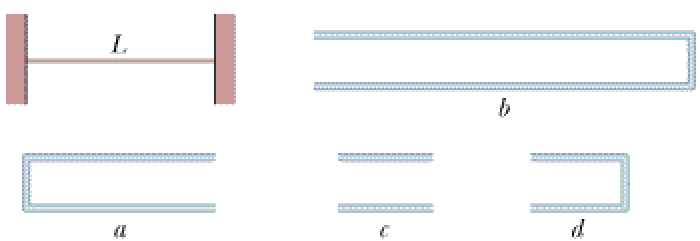
(a) Calculate the potential energy U of the Earth and projectile system at the time of its launch from the surface of the Earth. (**1 point**)

(b) Use result in part (a) to calculate the escape speed V_e of the projectile. The escape speed is the minimum initial speed of launch so that it escapes the earth's gravitational pull. (**1 point**)

(c) If the initial speed of the projectile is $V_e/2$ then calculate the farthest distance the projectile reaches from the surface of the Earth. (**1 point**)

Question 8: The motor in a refrigerator has power P. If the freezing compartment is at T_1 K and the outside air is at T_2 K, ($T_2 > T_1$) and assuming the efficiency of a Carnot refrigerator, what is the maximum amount of energy that can be extracted as heat from the freezing compartment in time t? (**2 points**)

Question 9: The figure below shows a stretched string of length L and pipes a, b, c, and d of lengths L, 2L, L/2, and L/2, respectively. The string's tension is adjusted until the speed of waves on the string equals the speed of sound waves in the air. The fundamental mode of oscillation is then set up on the string. In which pipe will the sound produced by the string cause resonance. Show your reasoning pictorially on the figure. (**1 point**)



Question 10: In the p-V diagram shown in the figure below, an ideal gas does work W_1 when taken along isotherm ab and work W_2 when taken along adiabat bc.

(a) How much heat is absorbed by the gas going from point a to point c when it goes along the path a to b to c. (**1 point**)

(b) What is the change in the internal energy of the gas when it is taken along the straight path from a to c? (**1 point**)