Physics 131
FINAL EXAM
1:30 - 3:18 pm, Wednesday, December 9, 1999

Fall 1999 Professor Frank De Lucia 2:30 Section

Name (1 pt):_____

Recitation Instructor (1 pt):_____

There are **7** pages to this exam (plus this page). It is important that you write your name on each page and the name of your recitation instructor on the first page. Each name is worth one point.

Be sure to include the proper units in your answers.

$$a = \frac{v^2}{r} \qquad F_g = \frac{GMm}{r^2} \qquad f_{s,\max} = \mu_s N$$

$$P = \frac{dW}{dt} \qquad U_g = mgh \qquad f_k = \mu_k N$$

$$U_g = -\frac{GMm}{r} \qquad F_s = -kx$$

$$U_s = \frac{1}{2}kx^2$$

$g = 9.8\ m/s^2 = 32\ ft/s^2$

$G = 6.67 \times 10^{-11}\ N\ m^2/kg^2$ $\qquad I = \Sigma\ m_i r_i^2$

Name (1 pt) _____

Section I - short problems (13 pts each)

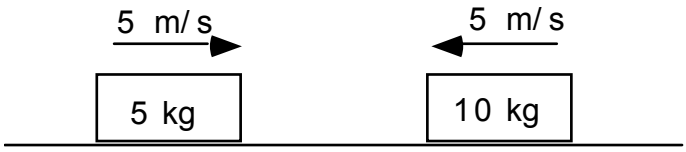
I-1 Two evenly matched tug-of-war teams each pull with a force of 8000 N. If a scale is placed in the middle of the rope, how many Newtons does it read while the teams are pulling?

I-2 A 500 kg cow is running across a flat field at 3 m/s. When it tries to stop, it slides for 10 m before coming to rest. What is the average force of friction that acted on the cow?

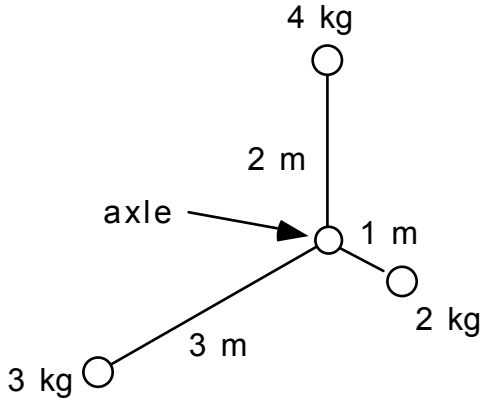
I-3 A 7 kg block is projected by a compressed spring (of spring constant 6000 N/m) up a frictionless 30^{o} incline plane. It travels 10 meters along the incline from its initial position. How far was the spring compressed?

Name (1 pt) _____

I-4 Two blocks of mass 5 kg and 10 kg respectively are moving toward each other on a frictionless surface, each with a speed of 5 m/s relative to the surface. They collide and stick together. What is their speed after the collision?

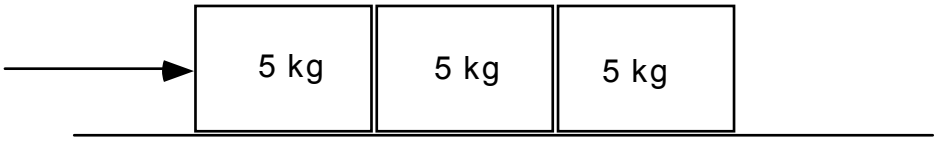


I-5 Three masses are arranged as shown in the diagram. What is the rotational inertia of this system about its axle?

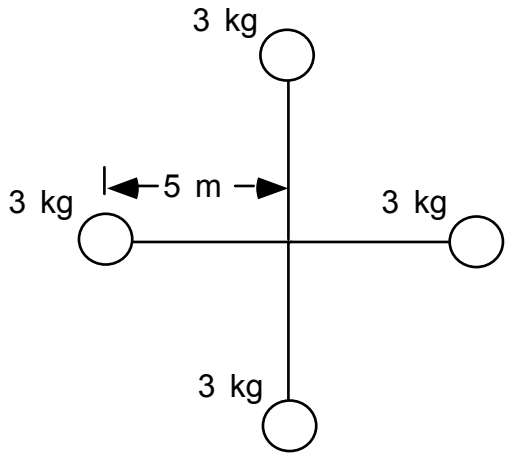


Name (1 pt) _____

I-6 Three identical 5 kg blocks are in contact atop a table with a frictionless surface. If a force of 150 N is applied as shown to the left block, what is the net force on the middle block?



I-7 Four masses lie atop a frictionless flat table and are attached to a central axis with massless cords as shown in the figure. The system is rotating with an angular velocity of $\omega = 3$ rad/s. What are the tensions in the cords?



Name (1 pt) _____

Section II - Problems (25 points each)

II-1 A cannon can fire a shell of mass 50 kg with a velocity of 1000 m/s relative to the cannon. If the cannon is mounted rigidly to a railroad car so that the combined mass of the railroad car and the cannon is 10000 kg and fires horizontally, what is the velocity of the shell relative to the ground? Assume that the railroad car is initially at rest and that its wheels are frictionless.

Name (1 pt) _____

II-2 Two blocks, of mass 10 kg and 20 kg collide on a frictionless table. The 10 kg block has an initial velocity of 5 m/s and the 20 kg block is stationary. After the collision, the 20 kg block has a velocity of 2 m/s.

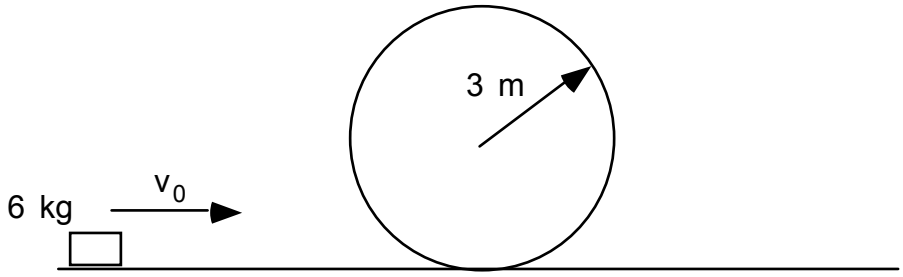
(a) After the collision, what is the velocity of the 10 kg block?

(b) How much energy is lost in the collision?

Name (1 pt) _____

II -3 A block of mass 6 kg approach a frictionless vertical loop of radius 3 m as shown in the figure. It has enough velocity so that it travels around the inside of the track and exits on the opposite side. If at the top of the loop the track exerts a normal force on the block equal to the magnitude of the block's weight:

(a) What is the speed of the block at the top of the loop?
(b) What must the initial velocity v_o of the block be?



Name (1 pt) _____

II-4 A mass of 7 kg is attached to a massless cord, which is wrapped around a 3 kg solid disk ($I_{disk} = MR^2/2$) so that it does not slip. If the masses are released from rest:

(a) How long does it take the 7 kg mass to fall 5 m?
(b) What is the tension in the cord?