

Physics 131: FINAL  
3:30 - 5:18 pm, Wednesday, December 7, 2000  
Professor Frank De Lucia

Fall 2000

3:30 Section

Name (1 pt): \_\_\_\_\_

Recitation Instructor (1 pt): \_\_\_\_\_

There are 7 pages to this exam (plus this page, a total of 8). 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.

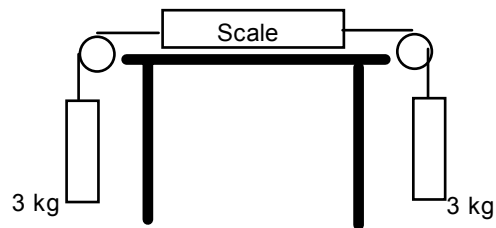
Name (1 pt) \_\_\_\_\_

**Section I - short problems (10 pts each)**

I-1 A 0.2 kg ball is dropped from a tower. Just before impact its velocity is 50 m/s. Immediately after it rebounds upward its speed is 30 m/s. If the ball is in contact with the ground for 0.1 s, what is the average force exerted on the ball by the ground?

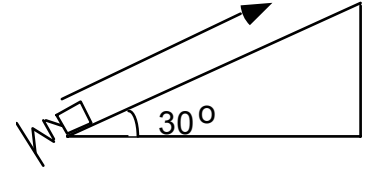
I-2 A disk, initially rotating at 200 rad/s, is slowed down with a constant angular acceleration of magnitude  $5 \text{ rad/s}^2$ . How much time elapses before the disk stops?

I-3 A 3 kg salami is attached to each end of a massless cord, which is hung over two pulleys as shown in the diagram. In the middle of the cord is placed a massless spring scale. What does the scale read in Newtons?

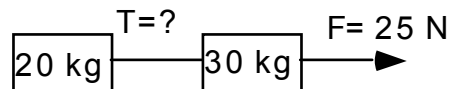


Name (1 pt) \_\_\_\_\_

I-4 A 5 kg block is accelerated by a spring which is compressed 0.1 m and whose spring constant is 60000 N/m. If the block starts from rest at the bottom of a frictionless incline plane of angle  $30^\circ$ , how far does it travel before coming to a rest again as measured along the incline?



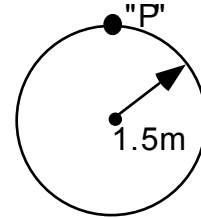
I-5 Two blocks of mass 20 kg and 30 kg are connected together by a massless string. A force of 25 N is applied to one of the blocks as shown in the figure. What is the tension in the string between the two blocks?



I-6 A block has an initial velocity of 15 m/s on a flat surface. The coefficient of friction between the block and the surface is 0.4. How far does the block slide before coming to rest?

Name (1pt) \_\_\_\_\_

I-7 A wheel of radius 1.5 m is rolling without slipping on a flat surface. It has an angular velocity of 7 rad/s. What is the linear velocity of point "P" at the top of the wheel?



I-8 A block slides around inside of a vertical frictionless track of radius 1m. What is the minimum speed it must have at the top so that it remains in contact with the track?

## Section II - Problems

II-1 (20 pts) A flag pole (a long thin rod) of length  $L$  stands vertically in a flat field. If it falls by rotating about its end, what is the velocity of the top of the pole as it hits the ground?

$$(I_{rod\ about\ end} = (1/3)ML^2)$$

Name (1 pt) \_\_\_\_\_

II-2 (20 pts). A wheel of rotational inertia  $I = 20 \text{ kg m}^2$  is rotating freely with an angular speed of  $\omega = 50 \text{ rad/s}$  on a shaft whose rotational inertia is negligible. A second wheel, initially at rest and with  $I = 40 \text{ kg m}^2$ , is suddenly coupled to the same shaft.

- (a) What is the angular speed of the combined system?
- (b) What fraction of the original rotational kinetic energy is lost?

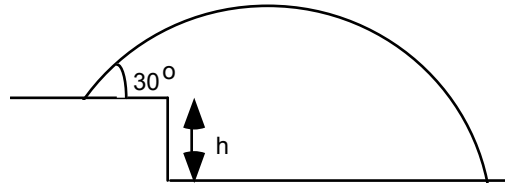
Name (1pt) \_\_\_\_\_

II-3 (24 pts) Two blocks, one of  $m_1 = 10$  kg and the other of  $m_2 = 15$  kg, are held together with a massless compressed spring between them. The energy stored in the spring is 60 J. How much kinetic energy does each block have after the two are released?

Name (1 pt) \_\_\_\_\_

II-4 (24 pts) A stone is projected off of a cliff of height  $h$  with an initial speed of 250 ft/s directed  $30^\circ$  above the horizontal, as shown in the figure. The stone strikes the ground 10 s later.

- (a) What is  $h$ , the height of the cliff?
- (b) How long does it take the stone to reach its maximum height?
- (c) What is the speed of the stone when it hits the ground?



Name (1pt) \_\_\_\_\_

III-5 (24 pts) A mass of 15 kg and a mass of 25 kg are attached to a massless string and hung over a 10 kg pulley (assume that it has the shape of a solid disk,  $I_{disk} = (1/2)MR^2$ ). If the masses are released from rest,

- (a) What is the linear acceleration of the system?
- (b) What is the magnitude of the tension in the string which is attached to the 25 kg mass?
- (c) What is the speed of the 25 kg mass after it has fallen 10 m?

