Physics 151 Roster No.:__________________________

Score: **18 pts. possible**

SPRING 2003 Midterm Exam #3, Part A

Exam time limit: 50 minutes. You may use calculators and both sides of 2 pages of notes, *handwritten only*. Closed book; no collaboration. For multiple choice questions, circle the one best answer or letter (unless more than one answer is asked for).

Some moments of inertia:

hoop or thin ring:	$I = M R^2$	thin rod, about center:	$I = (1/12)\, M L^2$
solid cylinder or disk:	$I = (1/2)\, M R^2$	thin rod, about end:	$I = (1/3)\, M L^2$
solid sphere:	$I = (2/5)\, M R^2$		

(1 pt. each, unless otherwise specified)

1. (2 pts.) A 5.0-kg mass traveling with velocity 10. cm/s to the right collides head-on with a 2.0-kg mass traveling with velocity v_2 to the left. They stick together in the collision. In order for the stuck-together pair to have *zero velocity* after the collision, the **speed v_2** must equal:

A. zero
B. 4.0 cm/s
C. 5.0 cm/s
D. 6.0 cm/s
E. 10. cm/s
F. 25 cm/s

2. A spaceship with total mass *M* is drifting through space at a constant velocity *V*.

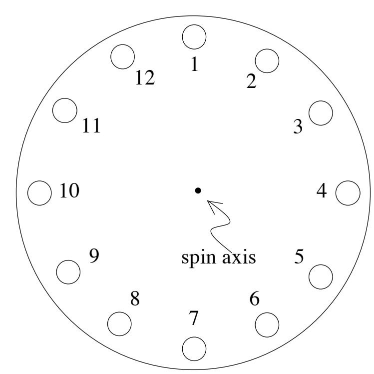
a. If the spaceship suddenly explodes, the **sum of the momenta** of all the little pieces is…

A. zero
B. less than *MV*
C. equal to *MV*
D. greater than *MV*

b. The **sum of the KE** of all the little pieces is… (*Hint:* The answer is the same as in the special case of $V = 0$.)

A. zero
B. less than $(1/2)MV^2$
C. equal to $(1/2)MV^2$
D. greater than $(1/2)MV^2$

3. (2 pts.) A centrifuge is designed to hold and spin as many as 12 test tubes simultaneously. It has evenly-spaced holders labeled #1 through #12, as shown. The centrifuge is properly "balanced" only when the *center of mass* of all of its contents is located exactly on the spin axis of the centrifuge. Which **two** of the following test tube configurations are **NOT** balanced?



A. #1 only
B. #1 and #7
C. #1, #5, #9
D. #1, #2, #7, #8
E. #1, #3, #7, #11
F. all filled except #4 and #10

4. A tightrope walker carries a long sideways pole to aid in balance. She can choose between two poles to use: both with the *same* mass, but one with *twice* the length of the other. She should choose the **longer** pole because…

A. it has the greater angular velocity
B. it has the greater angular acceleration
C. it has the greater weight
D. it has the greater moment of inertia

5. A child (m = 30 kg) is riding on the edge on a merry-go-round (M = 300 kg) spinning at angular speed ω. (Assume there is no air resistance or frictional torque acting on the system.) As the child slowly moves from the edge of the merry-go-round toward the center, which **one** of the following happens to the child+merry-go-round system?

A. ω increases
B. I increases
C. L increases
D. T increases

6. a. A standard "LP" music record spins at 33 rpm (revolutions per minute). What is its **angular speed**, ω?

A. 0.030 rad/s
B. 0.29 rad/s
C. 0.55 rad/s
D. 1.8 rad/s
E. 3.5 rad/s
F. 21 rad/s

b. (2 pts.) If a record player is accelerated from rest up to full speed at α = 1.4 rad/s^2, how many **revolutions** does it complete during this time?

A. 0.20 rev
B. 0.68 rev
C. 1.7 rev
D. 3.2 rev
E. 6.3 rev
F. 8.6 rev

c. (2 pts.) The turntable itself has a mass of 0.30 kg, radius of 15 cm, and a thickness of 3.0 mm. How much **torque** must the motor provide to accomplish the acceleration in part (b)?

A. zero
B. 2.3×10^{-3} m·N
C. 3.0×10^{-3} m·N
D. 4.7×10^{-3} m·N
E. 5.8×10^{-3} m·N
F. 1.6×10^{-2} m·N

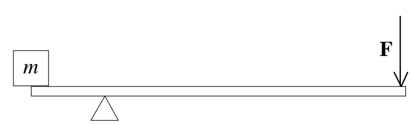
d. Once the turntable reaches full speed, how much **torque** must the motor provide to keep it at a *constant* 33 rpm?

A. zero
B. 2.3×10^{-3} m·N
C. 3.0×10^{-3} m·N
D. 4.7×10^{-3} m·N
E. 5.8×10^{-3} m·N
F. 1.6×10^{-2} m·N

7. A baton twirler is moving with a constant horizontal speed v when she throws her spinning baton high into the air. (A baton is basically a lightweight rod with a mass fixed to each end.) Ignoring air resistance, which **one** of the following is TRUE?

A. A baton will always spin about the rod's center, even if the masses on its two ends are different.
B. The baton will spin slowest at the very top of its arc, and fastest when it is closest to the ground.
C. The total KE of the baton is least at the very top of its arc, and greatest when it is closest to the ground.
D. The baton's center of mass moves with a complicated, loopy path through the air.

8. (2 pts.) A simple lever gives the user a mechanical advantage: pushing down with force F on the long end of the lever creates an upward force greater than F on the short end. If you want to (just barely) lift mass m using a lever of length L, and the fulcrum is located at a distance of exactly $L/7$ from the short end of the lever, with what **force** F must you push down on the long end?



A. $(1/7)\ mg$
B. $(1/6)\ mg$
C. $(1/\sqrt{7})\ mg$
D. $(1/\sqrt{6})\ mg$
E. $(5/6)\ mg$
F. $(6/7)\ mg$

9. The three great Conservation Laws we have encountered are:

A. Energy, Work, and Force
B. Momentum, Impulse, and Energy
C. Torque, Force, and Power
D. Inertia, Mass, and Energy
E. Momentum, Angular Momentum, and Energy
F. Kinetic Energy, Potential Energy, and Work done by non-conservative forces

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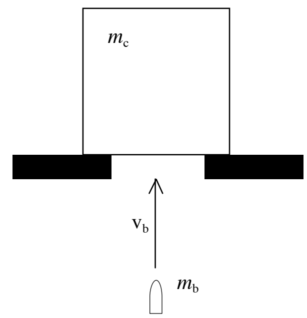
Score:_____22 pts. possible__________

SPRING 2003 Midterm Exam #3, Part B

Exam time limit: 50 minutes. You may use calculators and both sides of 2 pages of notes, *handwritten only*. Closed book; no collaboration. Show your work on free-response questions. Be sure to use **proper units** and **significant figures** in your final answers.

1. A bullet (mass m_b = 15.6 g) is fired directly upward into a wooden cube (m_c = 4.50 kg), where it lodges in the wood. The cube then flies up into the air to a maximum height h above its starting position.



a. (4 pts.) If the bullet has a velocity v_b = 426 m/s immediately before impact, and the cube starts at rest, what is the **velocity** of the bullet+cube immediately after impact? Show your work.

b. (1 pt.) Which one of the following is TRUE?

A. The collision is elastic because momentum is lost in the collision.
B. The collision is elastic because KE is lost in the collision.
C. The collision is elastic because momentum & KE are both lost in the collision.
D. The collision is inelastic because momentum is lost in the collision.
E. The collision is inelastic because KE is lost in the collision.
F. The collision is inelastic because momentum & KE are both lost in the collision.

c. (3 pts.) Find the **maximum height *h*** of the bullet+cube. Show your work.

2. A bowling ball (a uniform sphere with R = 10.8 cm and M = 7.25 kg) rolls at 5.00 m/s without slipping on a horizontal surface.

a. (5 pts.) Calculate the **TOTAL kinetic energy** of the bowling ball.

(2. cont'd.) b. (3 pts.) The bowling ball then encounters an incline. To what **height** will it roll before stopping? Show your work.

c. (1 pt.) You repeat the above experiment using a *hollow cylinder* (same M and R as the bowling ball) rolling at 5.00 m/s without slipping, and then using a *block* of ice (same M) sliding frictionlessly at 5.00 m/s. **Choose one**:

A. The bowling ball reaches the greatest height on the incline, and the block of ice the least.
B. The bowling ball reaches the greatest height on the incline, and the hollow cylinder the least.
C. The hollow cylinder reaches the greatest height on the incline, and the block of ice the least.
D. The block of ice reaches the greatest height on the incline, and the bowling ball the least.
E. The block of ice reaches the greatest height on the incline, and the hollow cylinder the least.
F. All three reach the same height on the incline.

3. (5 pts.) A heavy wood beam with length L and mass m is fixed to a wall at point P, and also suspended by a steel cable at angle α. (The mass of the cable is negligible.) Find the magnitude of the **force of tension** F_T in the cable, in terms of the variables m, L, α, and g.
(*Hint:* Sum the torques acting on the beam, using point P as the pivot. You will NOT also need to sum the forces acting on the beam. Not all of the variables will necessarily appear in your answer.)