General Physics I Exam 3 - Chs. 7,8,9 - Momentum, Rotation, Equilibrium Oct 29, 2008

Name: Rec. Instr.: Rec. Time:

For full credit, make your work clear to the grader. Show the formulas you use, essential steps, and results with correct units and significant figures. Partial credit is available if your work is clear. Points shown in parenthesis. Use g = 9.80 m/s^2. For TF and MC questions, choose the best answer.

1. (2) **T F** A collision is considered elastic if it conserves total momentum.

2. (2) **T F** A collision where two objects stick together is called completely inelastic.

3. (2) **T F** The force during a collision between two objects will be larger if the time in contact is larger.

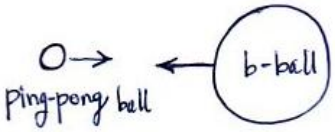
4. (2) **T F** When a 2-kg mass collides with a 5-kg mass, the masses experience equal but opposite impulses.

5. (8) Ralph throws a ball (mass = 145 grams) horizontally, his hand applying a force of 4.0 N horizontally over 0.22 s (ignore gravity here). Find

a) (4) The impulse applied to the ball:

b) (4) The speed of the ball when it left his hand:

6. (12) A ping-pong ball (m_A, very light) is travelling at 24 m/s due east when it collides head-on with a basketball (m_B, much much heavier) travelling at 12 m/s due west. Their collision is elastic.

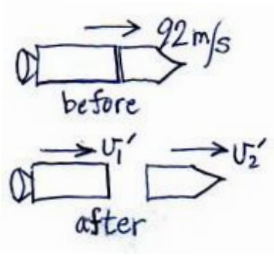


a) (4) Before they collide, at what speed are they approaching each other?

b) (4) After the collision, at what speed are they separating from each other?

c) (4) What is the velocity of the ping-pong ball (magnitude and direction) after the collision?

7. (12) A rocket far from earth moving at 92 m/s separates with an explosive charge, into a booster stage (1820 kg) and a capsule (680 kg), leaving the capsule moving at 28 m/s away from the booster.



a) (2) After they separate, their center of mass is moving at

a. $v_{\text{cm}} < 92$ m/s b. $v_{\text{cm}} = 92$ m/s c. $v_{\text{cm}} > 92$ m/s.

b) (2) Which experiences the greater magnitude force due to the explosive charge?

a. the booster b. the capsule c. they experience equal magnitude forces.

c) (2) Which experiences the greater magnitude impulse due to the explosive charge?

a. the booster b. the capsule c. they experience equal magnitude impulses.

d) (6) Find the speed of the capsule after they separate, using $v_2' = v_1' + 28$ m/s.

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8. (16) An engine's flywheel of radius 28.8 cm accelerates from rest to 2440 rpm in 3.00 s.

a) (6) What is the flywheel's angular acceleration, in rad/s^2?

b) (6) Through how many revolutions did it turn during the 3.0 seconds?

c) (4) During the acceleration, what was the tangential acceleration of a point on the edge of the wheel?

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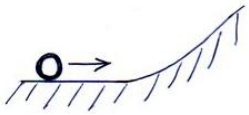
9. (6) A solid sphere ($I = \frac{2}{5}mR^2$), a solid cylinder ($I = \frac{1}{2}mR^2$), and a hoop ($I = mR^2$) of identical masses and radii are initially all rolling without slipping at 12 m/s on a level surface. Then they come to a gradual incline.



a) (2) While on the level surface, which one has the greatest translational kinetic energy?

a. sphere b. cylinder c. hoop d. all translational KE's are equal.

b) (2) While on the level surface, which one has the greatest rotational kinetic energy?

a. sphere b. cylinder c. hoop d. all rotational KE's are equal.

c) (2) Which one goes the highest up the incline?

a. sphere b. cylinder c. hoop d. it's a 3-way tie.

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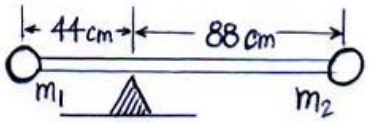
10. (16) A light (nearly massless) rod has masses $m_1 = 5.0$ kg and $m_2 = 2.0$ kg attached to its ends as shown. Placed on a pivot horizontally, it is initially unbalanced, and starts to rotate.



a) (6) How large is the rotational inertia of the rod with masses, about the pivot point as the axis?

b) (6) How large is the net torque acting on the rod with masses, and is it **clockwise** or **counterclockwise**?

c) (4) What is the magnitude of its initial instantaneous angular acceleration?

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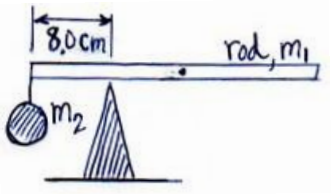
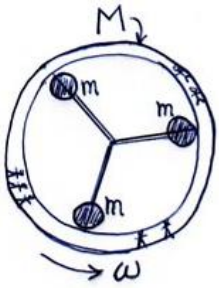
11. (8) In the diagram (not to scale), an unknown mass m_2 is suspended in equilibrium from the end of a uniform 2.00-kg rod (m_1) of 1.00 m length balanced on a pivot. How large is m_2?



12. (18) The living quarters of a space station is a giant hoop ($M = 24000$ kg) of outer radius 38 m. To control its rotational speed, three movable masses ($m = 18000$ kg) are added, whose distance from the center can be changed. Initially, the three masses are set at $r = 34$ m, and the angular velocity ω is set so people at the outer edge feel 1.00 g of centripetal acceleration.



a) (6) What is the initial angular velocity ω, in rpm?

b) (8) To perform experiments, the three movable masses are moved to $r' = 4.0$ m. What is the new angular velocity ω' (in rpm) of the space station?

c) (4) After moving the masses to $r' = 4.0$ m, how many g's of centripetal acceleration are the people at the outer edge experiencing?

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13. (8) A light fixture that weighs 60.0 N is suspended between ceiling and wall as shown, with $\theta = 30.0°$. Find the tensions T_1 and T_2 in the two supporting cables.