Physics 111 Sample Exam 3 **A**

Skip:
Nos. 6,7,10,11

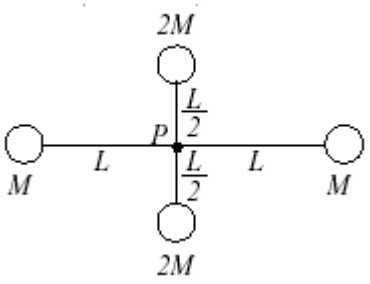
1. A 3 kg steel ball falls down vertically and strikes a floor with a speed of 12 m/s. It bounces off upward with the same speed. If the ball is in contact with the floor for 0.12 s, what is the magnitude of the average force exerted on the ball by the floor?
A) 200 N
B) 400N
C) 600 N
D) 800 N
E 1000 N

2. A baseball player uses a pitching machine to help him improve his batting average. He places the 60-kg machine on a frozen pond. The machine fires a 0.12-kg baseball horizontally at a speed of 36 m/s. What is the magnitude of the recoil velocity of the machine?
A) 3.6 cm/s
B) 7.2 cm/s
C) 10.4 cm/s
D) 15.2 cm/s
E) 36 cm/s

3. The turntable of a record player rotates at a rate of 18 rev/min. It takes 70 seconds for the turntable to come to rest when switched off. Calculate the magnitude of its angular acceleration.
A) 0.012 rad/s^2
B) 0.027 rad/s^2
C) 0.054 rad/s^2
D) 0.108 rad/s^2
E) 0.216 rad/s^2

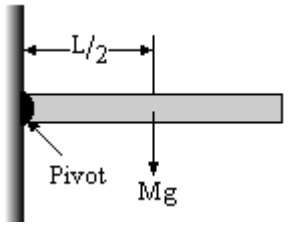
4. The turntable of a record player rotates at a rate of 18 rev/min. It takes 70 seconds for the turntable to come to rest when switched off. Calculate the number of revolutions it makes before coming to rest.
A) 2.3 rev
B) 3.14 rev
C) 5.3 rev
D) 7.6 rev
E) 10.5 rev

5. The rigid object shown is rotated about an axis perpendicular to the paper and through point P. If M = 2 kg and L = 0.9 m, what is the moment of inertia of the object? Neglect the mass of the connecting rods and treat the masses as point masses.



A) 1.2 kgm^2
B) 2.45 kgm^2
C) 3.65 kgm^2
D) 4.9 kgm^2
E) 6.15 kgm^2

6. A uniform rod of length 1.3-m and mass 29-kg is free to rotate about a frictionless pivot at one end in a vertical plane, as in the figure. The rod is released from rest in the horizontal position. What is the initial angular acceleration of the rod?



A) 2.4 rad/s^2
B) 4.8 rad/s^2
C) 7.3 rad/s^2

D) 9.8 rad/s^2
E) 11.3 rad/s^2

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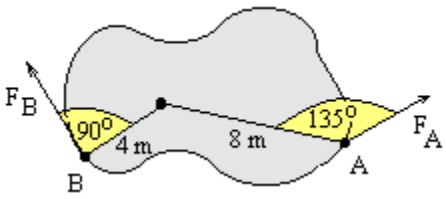
7. A grinding wheel is in the form of a uniform solid disk of rotational inertia I = 6.2*10^{-3}kgm^2. It starts from rest and accelerates uniformly under the action of the constant torque of 1.2 Nm that the motor exerts on the wheel. How long does the wheel take to reach its final speed of 736 rev/min?
A) 0.4 s
B) 0.6 s
C) 0.8 s
D) 1.4 s
E) 2.8 s

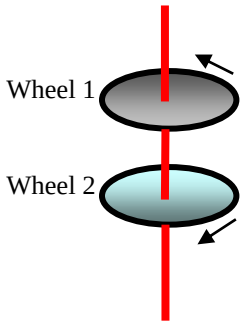
8. A light nylon cord is wound around a uniform cylindrical spool of radius 0.5-m and mass 1.2-kg. The spool is mounted on a frictionless axle and is initially at rest. The cord is pulled from the spool with a constant acceleration of magnitude 1.3 m/s^2. How much work has been done on the spool, when it reaches an angular speed of 10 rad/s?
A) 7.5 J
B) 10 J
C) 15 J
D) 20 J
E) 25 J

9. What is the rotational inertia of a meter stick, with mass 0.5-kg, about an axis perpendicular to the stick and located at the 20 cm mark. (Treat the stick as a thin rod.)
A) 0.087 kgm^2
B) 0.174 kgm^2
C) 0.35 kgm^2
D) 0.52 kgm^2
E) 0.70 kgm^2

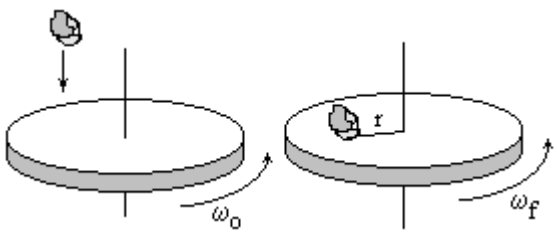
10. The body in figure is pivoted at O. Two forces act on it in the directions shown: F_A=10 N at point A, 8 m from O; F_B=16 N at point B, 4 m from O. What is the net torque about O?
A) -7.4 Nm
B) -3.7 Nm
C) 0 Nm
D) +3.7 Nm
E) +7.4 Nm



11. One wheel of rotational inertia I_1=2 kgm^2 is rotating freely at 20 rad/sec in counterclockwise direction on a shaft whose rotational inertia is negligible. A second wheel of rotational inertia I_2=5 kgm^2, rotating freely at 15 rad/sec in the opposite direction, is suddenly coupled along the same shaft to the first wheel. Afterwards, the coupled wheel system rotates at
A) 1.0 rad/s, counterclockwise
B) 2.25 rad/s , clockwise
C) 4.5 rad/s , clockwise
D) 5.0 rad/s , counterclockwise
E) 5.0 rad/s , clockwise



12. A 4-g object is dropped onto a record of rotational inertia I = 200 gcm^2 initially rotating freely at 78 revolutions per minute (rpm). The object adheres to the surface of the record at distance 5 cm from its center. The angular velocity of the record is
A) 24 rpm
B) 36 rpm
C) 42 rpm

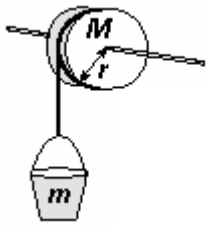


D) 52 rpm
E) 78 rpm

Physics 111 Exam 3 Name (please print) _____ **A**

Workout Problem 1. A driver traveling at 56 m/s in a car of mass 1100 kg runs into the rear end of a police car of mass 1500 kg, traveling at 15 m/s. The collision is completely inelastic, and all motion is restricted to a straight line. a) Immediately following the collision, what is the shared velocity of the two cars? b) The engines stop working, wheels lock up, and the coefficient of kinetic friction of the cars is 0.7. What is the magnitude of the frictional force acting on the two cars as they slide to a halt? c) What is the kinetic energy of the two cars immediately following the collision?

Workout Problem 2. A cylindrical pulley with a mass of M = 6 kg and a radius of r = 0.7 m is used to lower a bucket with a mass of m = 3 kg into a well. a) What is the rotational inertia I of the pulley? b) What is the linear acceleration of the falling bucket?



1C, 2B, 3B, 4E, 5D, 6E, 7A, 8A, 9A, 10A, 11E, 12D

Skip Nos. 5,8,11,12

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The exam is closed book and closed notes.

Circular motion: $a_c = \frac{v^2}{R}$; $F_{net} = ma$; **Weight:** $F_g = mg$, ; $g = 9.8\ m/s^2$; $P_{avr} = \frac{W}{\Delta t}$

Kinetic energy: $K = \frac{1}{2} m v^2$; **Potential energy:** $U_g = mgy$ $E_i = E_f$ $E = U+K$

Rotational motion: $\theta = \frac{s}{r}$; $1\ rev = 2\pi\ rad$; $v = \omega r$; $a_t = \alpha r$; $a_r = \frac{v^2}{r} = \omega^2 r$;

$\omega = \omega_0 + \alpha t$; $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$; $2\theta\alpha = \omega^2 - \omega_0^2$ $K = \frac{1}{2} I\omega^2$ $\tau = r \times F$; $\tau = rF\sin\phi$;

$\Sigma\tau = I\alpha$; $I_{point\ mass} = mr^2$ $I_{disk} = \frac{1}{2} mR^2$ $I_{cyl} = \frac{1}{2} mR^2$ $I_{pipe} = \frac{1}{2} m\left(R_{out}^2 + R_{in}^2\right)$

$I_{hoop} = mR^2$ $I_{rod(center)} = \frac{1}{12} mL^2$ $I_{rod(end)} = \frac{1}{3} mL^2$ $I_{ball} = \frac{2}{5} mR^2$ $I_{shell} = \frac{2}{3} mR^2$

$I = I_{com} + MD^2$ **work:** $W = \tau\theta$; $K = \frac{1}{2} I\omega^2$ $W = \frac{1}{2} I\omega_f^2 - \frac{1}{2} I\omega_i^2$ $P = \frac{dW}{dt}$ $P_{avr} = \frac{W}{\Delta t}$

Rolling: $v_{com} = R\omega$ $K = \frac{1}{2} I\omega^2 + \frac{1}{2} m v_{com}^2$ $\tau = f_s R$ $F_{s,max} = \mu_s Fn$

Incline: $F_{gx} = mg\sin\theta$ $F_{gy} = mg\cos\theta$

Angular momentum: $L_{point\ mass} = m\ r \times v$ $L = mrv\sin\theta$; $L = m(r_x v_y - r_y v_x)k$ $L = I\omega$

$L_I = L_f$ $I_1\omega_1 = I_2\omega_2$ $x_{com} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$ $y_{com} = \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2}$

NAME _____SCORE_____

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1. A 3.0-kg ball with an initial velocity of (4**i** + 3**j**) m/s collides with a wall and rebounds with a velocity of (–4**i** + 3**j**) m/s. What is the impulse exerted on the ball by the wall?

A) +24**i** N s
B) –24**i** N s
C) +18**j** N s
D) –18**j** N s
E) +8.0**i** N s

2. An 80-g particle moving with an initial speed of 50 m/s in the positive *x* direction strikes and sticks to a 60-g particle moving 50 m/s in the positive *y* direction. What is the magnitude of the velocity of the composite system after the collision?

A) 36 m/s
B) 50 m/s
C) 75 m/s
D) 86 m/s
E) 11 m/s

3. A merry-go-round rotates from rest with an angular acceleration of 1.56 rad/s^2. How long does it take to rotate through the first 2 rev?

A) 2 s
B) 4 s
C) 6 s
D) 8 s
E) 10 s

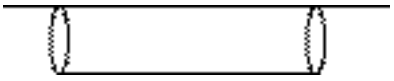
4. A wheel, with radius R = 0.5 m, initially has an angular velocity of 2.5 rev/s, and is slowing down at a rate of 2 rad/s^2. By the time it stops spinning about its center, what distance will a point on the outer rim have traveled?

A) 12 m
B) 18 m
C) 24 m
D) 31 m
E) 47 m

5. An electric motor can accelerate a 4-kg grinding wheel in a form of a solid disk of radius 0.2 m from rest to 75 rad/s in 15 s. Find the torque generated by the motor.

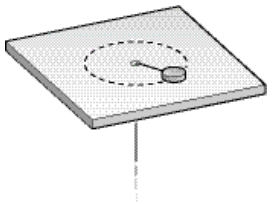
A) 0.05 N·m
B) 0.10 N·m
C) 0.20 N·m
D) 0.30 N·m
E) 0.40 N·m

6. A uniform cylinder of radius *R*, mass *M* , and length *L* rotates freely about a horizontal axis parallel and tangent to the cylinder, as shown below. The moment of inertia of the cylinder about this axis is



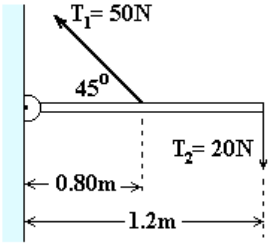
A) $\frac{1}{2}MR^2$.
B) $\frac{2}{3}MR^2$.
C) MR^2
D) $\frac{3}{2}MR^2$**.**
E) $\frac{7}{5}MR^2$.

7. A puck on a frictionless air hockey table has a mass of 0.5 kg and is attached to a cord passing through a hole in the surface as in the figure.The puck is revolving at a distance 2.0 m from the hole with an angular velocity of 0.40 rev/s. What is the kinetic energy of the puck?



A) 2.4 J
B) 4.8 J
C) 6.3 J
D) 12.6 J
E) 18.4 J

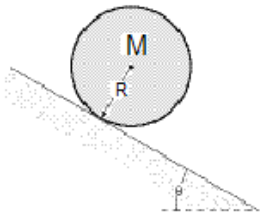
8. What is the magnitude of the net torque produced by two tension forces T_1 and T_2 about the hinge?



A) 4.3 Nm
B) 18.5 Nm
C) 28.7 Nm
D) 43.5 Nm
E) 52.3 Nm

9. A solid ball of mass of 0.25 kg rolls without slipping 4 m down an incline that makes an angle of 25^0 a with a horizontal. If it starts from rest, what is its kinetic energy at the bottom of the incline ?

A) 1 J
B) 2 J
C) 4 J
D) 6 J
E) 8 J

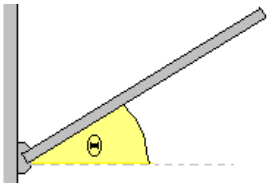


10. A basketball is rolling without slipping along a horizontal surface with total kinetic energy 20 J. How much energy (in Joules) is due to the rotational kinetic energy of the ball about its center of mass? Basketballs are hollow shells. ($I = 2/3\ mr^2$.)

A) 10
B) 8
C) 13.3
D) 4
E) 12

11. A thin uniform rod (length = 1.2 m, mass = 2.0 kg) is pivoted about a horizontal, frictionless pin through one end of the rod. The rod is released when it makes an angle of 25° with the horizontal. What is the angular acceleration of the rod at the instant it is released?

A) 11.1 rad/s^2
B) 7.4 rad/s^2
C) 8.4 rad/s^2
D) 5.9 rad/s^2
E) 6.5 rad/s^2



12. In the instant of the figure, two particles move in an *xy* plane. Particle P_1 has mass 2.5 kg and speed 4.2 m/s, and it is at distance d_1 =2.0 m from point *O*. Particle P_2 has mass 6.0 kg and speed 3.5 m/s, and it is at distance d_2 =1.5 m from point *O*. What are the magnitude (in kgm^2/s) and the direction of the net angular momentum of the two particles about O?

A) $\underline{\mathbf{L}} = -8\,\underline{\mathbf{i}} + 2\,\underline{\mathbf{j}}$
B) $\underline{\mathbf{L}} = -10.5\,\underline{\mathbf{k}}$
C) $\underline{\mathbf{L}} = 0$
D) $\underline{\mathbf{L}} = 52.5\,\underline{\mathbf{k}}$
E) $\underline{\mathbf{L}} = 10.5\underline{\mathbf{k}}$