Name (printed)_______________________________________

Name (signature as on ID)_______________________________________

Lab Section Number_________ Exam 3 Chpts. 9-11 in Young&Geller

The formula sheet is the last page of the exam.

Multiple Choice questions. Circle the correct answer. No work needs to be shown.

(6 pts) 1. A metal bar that has length $L$ is pivoted about a hinge at its lower end. A horizontal force $F$ is applied to the other end of the bar. The force vector for $F$ makes an angle $\theta$ with the bar. For an axis at the hinge, the magnitude of the torque due to $F$ is

(a) zero
(b) $FL \sin \theta$
(c) $FL \cos \theta$
(d) $FL$
(e) none of the above

(6 pts) 2. A solid cylinder of radius $R = 0.060$ m, length $L = 0.120$ m and mass $M = 4.00$ kg is pivoted about a frictionless axle that lies along the axis of the cylinder. The moment of inertia of the cylinder for an axis along the axle is $\frac{1}{2} MR^2$. A force $F$ is applied tangential to the rim of the cylinder. What must $F$ be in order to produce an angular acceleration of the cylinder equal to 100.0 rad/s$^2$?

(a) 1.5 N
(b) 3.0 N
(c) 6.0 N
(d) 12.0 N
(e) 24.0 N
(f) none of the above

(6 pts) 3. A block attached to a spring is moving with simple harmonic motion on a frictionless surface. The amplitude of the motion is 0.30 m and the frequency is 2.0 Hz. What is the frequency if the amplitude of the motion is decreased to 0.15 m?

(a) 4.0 Hz
(b) 8.0 Hz
(c) 1.0 Hz
(d) 2.0 Hz
(e) none of the above
On the following five problems show all your work. Partial credit will be given if earned. Write your answers in the blanks provided. Each numerical answer MUST include the correct units.

(15 pts) 4. A wheel with radius 0.200 m starts from rest at $t = 0$ and then starts to rotate with constant angular acceleration about an axis at its center. At $t = 5.0$ s the wheel has turned through 4.00 rev.

(a) What is the angular acceleration of the wheel, in rad/s$^2$.

Ans. $2.0 \text{ rad/s}^2$

(b) At $t = 5.0$ s, what is the angular velocity of the wheel, in rad/s?

Ans. $10.1 \text{ rad/s}$

(c) At $t = 5.0$ s, what is the magnitude of the linear velocity of a point on the rim of the wheel?

Ans. $2.01 \text{ m/s}$
5. A horizontal platform in the shape of a uniform disk \( I = \frac{1}{2} MR^2 \) for an axis at its center is rotating without friction about a vertical axis at its center. The platform has mass 8.00 kg and radius 0.400 m. The platform is initially rotating at an angular velocity of 0.300 rev/s. Then a small bag of sand with mass 6.00 kg is dropped from a small height onto the platform at its rim. The bag of sand can be treated as a point mass. What is the final angular velocity of the platform after the bag of sand has been dropped onto it?

Ans. 0.120 rev/s

\[
0.754 \text{ rad/s}
\]
6. A thin-walled hollow cylinder \((I = MR^2)\), with mass \(M = 3.00\) kg and radius \(R = 0.200\) m, is rolling without slipping at the bottom of a hill. At the bottom of the hill the center of mass of the cylinder has translational velocity 16.0 m/s. The cylinder then rolls without slipping to the top of a hill. The top of the hill is a vertical height of 6.00 m above the bottom of the hill. What is the translational velocity of the center of mass of the cylinder when the cylinder reaches the top of the hill?

Ans. \([14.0\ \text{m/s}]\)
(18 pts) 7. A uniform bar \((I = \frac{1}{3} ML^2)\) for an axis at one end) has mass \(M = 8.00\) kg and length \(L = 6.00\) m. The lower end of the bar is attached to a wall by a frictionless hinge. The bar is held at an angle of 30.0° above the horizontal by a wire that is attached between the upper end of the bar and the wall. The wire makes an angle of 53.1° with the bar.

a) With the bar held motionless, what are the horizontal \((H_h)\) and vertical \((H_v)\) components of the force that the hinge exerts on the bar?

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\begin{align*}
H_h & = 39.0 \text{ N} \\
H_v & = 61.8 \text{ N}
\end{align*}
\]

b) If the wire breaks, what is the initial acceleration (in rad/s²) of the bar, just after the wire breaks?

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\text{Ans. } 2.12 \text{ rad/s}^2
\]
(16 pts) 8. A 0.300 kg glider on an air track is attached to the end of an ideal spring that has force constant 500 N/m. The glider is moving in simple harmonic motion. When the glider is at $x = 0.200$ m it is moving in the negative direction with a speed of 12.0 m/s. What is the maximum velocity of the glider during its motion?

Ans. $4.5 \text{ m/s}$