Exam 3  Chapters 9-11 in Young 9e

On the following problems show all your work. Partial credit will be given, if earned. Write your answers in the blanks provided. All answers must include the correct plus or minus sign and the correct units.

(6 pts). 1. A block is attached to one end of a horizontal spring and moves on a horizontal frictionless surface. The other end of the spring is attached to a wall. When the amplitude of the motion is 0.060 m, the period is 1.50 s. What is the period if the amplitude is changed to 0.180 m?

Ans. ________________________

(12 pts) 2. A man holding a heavy object in each hand stands on a small platform that is free to rotate about a vertical axis. Initially he is standing with his arms outstretched and he and the platform are rotating with an angular velocity of 0.600 rad/s. With his arms outstretched, the moment of inertia of the system (man + platform + weights) is 4.00 kg·m². Then he pulls the weights in close to his chest, and the angular velocity of the rotating system becomes 1.80 rad/s.

a) What is the moment of inertia of the system after he has pulled his arms in?

Ans. ________________________

b) How much work did the man do when he pulled his arms in?

Ans. ________________________
(12 pts) 3. A large wheel of radius 0.300 m is initially at rest and then starts to rotate with a constant angular acceleration of 0.400 rad/s² about an axle at its center. What is the tangential velocity of a point on the rim of the wheel after the wheel has turned through 1.60 rad?

Ans. ________________________

(14 pts) 4. A large wheel with radius \( R \) is mounted on a frictionless axle that passes through the center of the wheel. A light rope is wrapped around the wheel and a block is suspended from the free end of the rope. When the system is released from rest, the block has a downward acceleration of magnitude 5.00 m/s² and the tension in the rope as the block descends is 60.0 N. \( R = 0.30 \text{ m} \).

\[ 5 \text{ m/s}^2 \]

\[ \begin{array}{c}
\text{60 N} \\
\downarrow 5 \text{ m/s}^2
\end{array} \]

a) What is the mass of the block?

Ans. ________________________

b) What is the moment of inertia of the wheel, for an axis at its center?

Ans. ________________________
(18 pts) 5. A block is attached to one end of a horizontal spring and moves on a horizontal frictionless surface. The other end of the spring is attached to a wall. The mass of the block is 0.400 kg and the force constant of the spring is $k = 300 \text{ N/m}$. When the block is at $x = -0.200 \text{ m}$ its speed is 5.00 m/s.

a) What is the amplitude of the motion?  
Ans. ________________________

b) What is the maximum speed of the block during its motion?  
Ans. ________________________

c) What is the maximum acceleration of the block during its motion?  
Ans. ________________________
(18 pts) 6. A uniform bar \( I = \frac{1}{3} M L^2 \) for an axis at one end) has mass \( M = 5.00 \text{ kg} \) and length \( L = 6.00 \text{ m} \). The lower end of the bar is attached to the wall by a frictionless hinge. The bar is held stationary at an angle of 60° above the horizontal by a cable that runs from the upper end of the bar to the wall. The cable makes an angle of 37° with the bar.

(a) For an axis at the hinge, what is the torque due to the weight of the bar?

Ans. ____________________

(b) What is the tension in the cable?

Ans. ____________________

(c) If the cable breaks, what is the initial angular acceleration of the bar right after the cable breaks?

Ans. ____________________
(20 pts) 7. A thin-walled hollow sphere with mass $M = 2.00 \text{ kg}$ and radius $R = 0.0500 \text{ m}$ has a moment of inertia of $I = \frac{2}{3} MR^2$ for rotation about an axis through its center. Initially the sphere is rolling without slipping on a level horizontal surface and its center of mass has a translational speed of $v_{cm} = 8.00 \text{ m/s}$. The sphere then rolls without slipping up a ramp that is inclined at $37^\circ$ above the horizontal.

a) What is the total kinetic energy (translational plus rotational) of the sphere when it is at the bottom of the ramp?

Ans. ____________________

b) What maximum vertical height $h$ above the bottom of the ramp does the sphere reach before it stops and starts to roll back down?

Ans. ____________________

c) What is the magnitude of the friction force that the ramp exerts on the sphere while the sphere is rolling up the ramp?

Ans. ____________________