Your Name: _____

PHY203
Exam #4
Chapters 5,9,10,14
Mon., 4/29/13

Solutions

1. A 2.00 kg ball at the end of a 1.50 m long string is rotating at a constant speed of 3.50 m/s in a horizontal plane.

a. Find the angular speed of the ball.

$$\omega = \frac{v}{r} = \frac{3.50}{1.5} = 2.33 rad/s$$ **5**

b. Find the period of the ball.

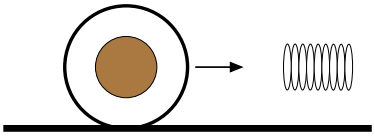
$$T = \frac{\omega}{2\pi} = \frac{2.33}{2\pi} = 2.69 s$$ **5**

c. Find how many revolutions the ball makes in 55.0 s.

$$N = \frac{55.0}{2.69} = 20.4 rev$$ **5**

d. Find the magnitude of the tension in the string.

$$T = m\frac{v^2}{r} = m(2.00)\frac{(3.50)^2}{1.50} = 16.3N$$ **5**



2. A concentric cylinder is rolling along the ground with a linear speed of 3.50 m/s. The inner cylinder is solid with a mass of 4.00 kg and a radius of 0.500 m. The outer thin cylinder is hollow with mass of 2.50 kg and a radius of 0.750 m.
a. Find the moment of inertia of the object.

$$I = \frac{1}{2}M_iR_i^2 + M_oR_o^2 = \frac{1}{2}(4.00)(0.500)^2 + (2.50)(0.750)^2 = 1.91\ \text{kgm}^2$$ **10**

b. Find the angular speed of the object.

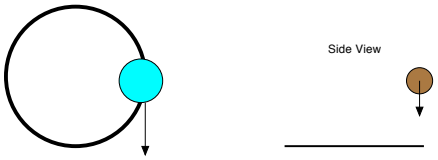
$$\omega = \frac{v}{r} = \frac{3.50}{0.750} = 4.67 rad/s$$ **5**

c. Find the kinetic energy of the object.

$$K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}(6.50)(3.50)^2 + \frac{1}{2}(1.91)(4.67)^2 \ \frac{1}{2}I\omega^2$$ **10**
$$= 60.7J$$

d. The object runs into a spring with a spring constant of 500 N/m. Use conservation of energy to find the maximum compression of the spring.

$$K = 60.7 = \frac{1}{2}kx^2 = \frac{1}{2}(500)x^2$$ **5**
$$x = 0.493m$$



3. a. A ball of mass 0.500 kg is rotating clockwise as viewed from above in a horizontal circle of radius 2.00 m with a speed of 2.50 m/s on some kind of track. a. Find the angular velocity of the ball and express it in vector notation. Take the z-axis in the positive direction out of the paper.

$\omega = \frac{v}{r} = \frac{2.50}{2.00} = 1.25 rad/s$

$\vec{\omega} = -1.25 rad/s\,\hat{k}$ **5**

by right hand rule

b. Find the magnitude of the angular momentum of the ball.

L=Iω= $(M_b R_b^2)\omega' = (0.500)(2.00)^2(1.25)$ **5**

=2.50 kgm^2/s

c. A blob of clay of mass 0.150 kg is dropped onto the moving ball from above and sticks to it. Assume the clay is traveling at a speed of 2.00 m/s in the vertical direction just before it lands. Find the magnitude of the angular momentum of the ball/clay system just after the collision.

same as b. 2.50 kgm^2/s **5**

d. Find the magnitude of the angular speed of the ball/clay system after the collision.

conservation of angular momentum:

$2.50 = (M_b R_b^2 + M_c R_c^2)\omega'$

$= [(0.500)(2.00)^2 + (0.150)(2.00)^2]\omega'$ **10**

$\omega' = 0.962 rad/s$

4. A spring has spring constant 1.50 kN/m. A block of 3.00 kg is attached to the spring which is then stretched by a distance of 25.0 cm and released.

a. Find the angular frequency of the oscillating spring.

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{1.50x10^3}{3.00}} = 22.4 rad/s$$ **5**

b. Find the period of the system.

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{22.4} = 0.281 s$$ **5**

c. Find the amplitude of the system.

A = 0.250 m **5**

d. Write the equation of motion (x vs. t) of the oscillating block.

x(t) = (0.250)cos(22.4t) **5**

e. Find the maximum speed of the block.

$$v = \frac{dx}{dt} = -\omega A \sin(\omega t)$$ **5**

$$v_{\max} = \omega A = (22.4)(0.250) = 5.60 m/s$$