Practice Exam #4

Do not flip the page until told to do so.

Name: _____

Problem	Grade	Points Possible
1		5
2		5
3		5
4		15
5		15
6		15
Total		60

Useful Equations

$$x(t) = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$$
$$y(t) = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$$
$$v_x(t) = v_{0x} + a_x t$$
$$v_y(t) = v_{0y} + a_y t$$
$$v_{fx}^2 = v_{0x}^2 + 2a_x\Delta x$$
$$v_{fy}^2 = v_{0y}^2 + 2a_y\Delta y$$

$$a_c = \frac{v^2}{r}$$
$$\theta(t) = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$$
$$\omega(t) = \omega_0 + \alpha t$$
$$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$
$$\sum_i \vec{\tau}_i = I\vec{\alpha} = \frac{d\vec{L}}{dt}$$

$$x(t) = A\cos(\omega t + \phi_0)$$
$$\omega = 2\pi f = 2\pi/T$$
$$v_{max} = A\omega$$
$$a_{max} = A\omega^2$$
$$v = \sqrt{F_T/\mu}$$
$$v = \lambda f$$
$$\omega_{spring} = \sqrt{k/m}$$
$$\omega_{pendulum} = \sqrt{g/L}$$
$$k = 2\pi/\lambda$$

$$\sum_i \vec{F}_i = m\vec{a} = \frac{d\vec{p}}{dt}$$
$$\vec{p} = m\vec{v}$$
$$F_{fr} = \mu_{s,k}F_N$$

$$K = \frac{1}{2}mv^2$$
$$K = \frac{1}{2}I\omega^2$$
$$U = mgy \text{ (gravity)}$$
$$U = \frac{1}{2}kx^2 \text{ (spring)}$$

$$a = R\alpha$$
$$v = R\omega$$
$$\vec{L} = I\vec{\omega}$$
$$\vec{L} = \vec{r}\times\vec{p}$$
$$I = \sum_i m_i R_i^2$$

$$\vec{P}_0 = \vec{P}_f$$
$$\vec{L}_0 = \vec{L}_f$$
$$\Sigma p_{0x} = \Sigma p_{fx}$$
$$\Sigma p_{0y} = \Sigma p_{fy}$$

Question 1: A rod of length L and moment of inertia I is free to rotate about one end. Compare the torque required to rotate the rod with some fixed angular acceleration α when

(a) a mass m is attached $L/3$ away from the axis of rotation.

(b) a mass m is attached $2L/3$ away from the axis of rotation.

(c) a mass m is attached L away from the axis of rotation.

Question 2: When a woman on a frictionless rotating turntable extends her arms out horizontally, her angular momentum:

(a) must increase

(b) must decrease

(c) must remain the same

(d) may increase or decrease depending on her initial angular velocity

(e) tilts away from the vertical

Question 3: A 2.0-kg stone is tied to a 0.50-m long string and swung around a circle at a constant angular velocity of 12 rad/s. The net torque on the stone about the center of the circle is:

(a) 0

(b) 6.0 N m

(c) 12 N m

(d) 72 N m

(e) 140 N m

Question 4: A carousel has a 7-m radius and requires 8 s for a single revolution at full speed. A pig sits 3 m from the axis, and a horse sits 6 m from the axis.

(a) What is the period of the a single revolution of the pig?

(b) Same, for the horse?

(c) What is the angular velocity of the pig?

(d) Same, for the horse?

(e) What is the velocity of the pig?

(f) Same, for the horse?

(g) What is the centripetal acceleration of the pig?

(h) Same, for the horse?

Question 5 Two masses connected to either end of a long rod are supported by a fulcrum. Mass 1 is at the left end with $x_1 = 0$ m and $m_1 = 7$ kg; mass 2 is at the right end with $x_2 = 3$ m and $m_2 = 12$ kg. The fulcrum is placed at $x_f = 1$ m, i.e. 1 meter from the left mass.

(a) Find the net torque on the system.

(b) Find the angular acceleration of the system.

(c) What is the linear acceleration of mass 1?

(d) What is the linear acceleration of mass 2?

(e) How far will mass 2 have moved after 0.5 s?

Question 6: A circular disk of mass M and radius R_0 is at rest with its edge on the ground. A bullet of mass m hits and sticks to the disk near the top edge, causing it to roll. Assuming that momentum is conserved during the collision (that is, ignoring the friction from the ground), what is the linear and angular velocity of the disk after the impact? As a bonus, compare the kinetic energy before and after—is it conserved? (note: $I_{disk} = \frac{1}{2}MR_0^2$).