Practice Exam #2

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: — At a certain instant, a fly ball has velocity $\vec{v} = 25\hat{i} - 4.9\hat{j}$ m/s, where the x axis is horizontal and the y axis is vertical. Positive y is upward, and positive x is to the right.

(a) The ball is at the top of its trajectory.

(b) The ball has already reached the top of its trajectory.

(c) The velocity of the ball is negative.

(d) The ball is no longer accelerating.

Question 2: A block sits 1 m up an plane inclined 30° above the horizontal. When the block is released, it accelerates down the incline. Draw a picture of the situation with a coordinate axes and compile a list of knowns and unknowns, with variables and their values where appropriate.

Question 3: A block sits at rest on a rough horizontal surface. The block is pulled to the right with a force of 10 N, yet the block does not move. Which of the following statements is definitely true?

(a) The block is heavier than 10 N.

(b) The coefficient of static friction is greater than 10 N.

(c) The friction force is 10 N.

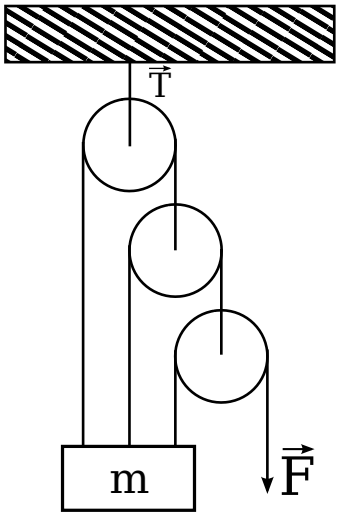
(d) The normal force is 10 N.

Question 4: Consider the fly ball from problem 1 where the velocity is $\vec{v} = 25\hat{i} - 4.9\hat{j}$ m/s. If we assume the height of the ball at that moment is 30 m, then

(a) how much time will elapse before it strikes the ground?

(b) what is the *total speed* of the ball **right before** it hits the ground?

Question 5: Consider the pulley system below. Each pulley is massless and the system is at rest. If the mass of the block is $m = 10$ kg, find the force $\vec{F}$ and the tension $\vec{T}$ required to keep the system motionless.



(hint: you actually have four unknowns—the tensions in the four strings—so you will need four equations; luckily, you have four objects onto which you can apply $F_{net} = ma$)

Question 6: A block of mass $m = 10$ kg sits at rest upon an inclined plane with an angle of $\theta = 35°$. A rope, connected to a hanging mass ($M = 5$ kg) by a massless pulley, holds the block in place by pulling it up the incline. What is the minimum coefficient* of static friction between the block and the inclined plane?

*5 extra points for a solution in terms of variables/constants only, followed by a numerical result.

Bonus Question: A swimmer attempts to swim across a 30 m wide river which has a current of 2 m/s. The swimmer's maximum speed is 4 m/s in still water.

(a) What is the shortest amount of time that it will take to reach the other side? Draw a picture!

(b) What angle, with respect to the shore, does the swimmer swim in part (a)?