Practice Exam #2

Name: ______________________________

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 boy holds a 40-N weight at arm's length for 10 s. His arm is 1.5 m above the ground. The work done by the force of the boy on the weight while he is holding it is:

(a) 0

(b) 6.1 J

(c) 40 J

(d) 60 J

(e) 90 J

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: A nonconservative force:

(a) violates Newton's second law

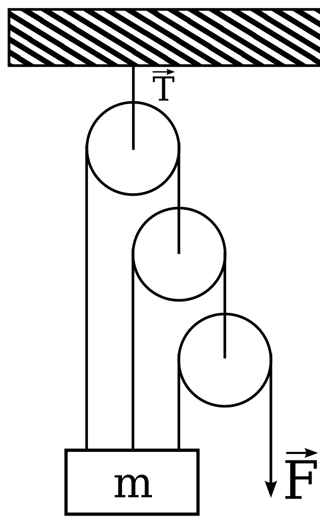
(b) violates Newton's third law

(c) cannot do any work

(d) must be perpendicular to the velocity of the particle on which it acts

(e) none of the above

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.

Question 7: A block of mass m moves with a velocity of 3 m/s along a frictionless horizontal surface. The block then encounters a rough patch of unknown length and slides up a frictionless hill, coming to a height $h = 0.25$ m before sliding back down. The same block is then sent through the system but with a speed of 6 m/s. What is the height that the block slides up the second time? (use Energy principles!)

Question 8: A block of mass m slides along a frictionless table at a speed v toward a wall. A massless spring of spring constant k is attached to the wall in the path of the block. When the block contacts the spring, the spring compresses.

(a) What will be the maximum compression of the spring x_{max}?

(b) What will be the instantaneous speed of the block when the spring is compressed by an amount x, with $x < x_{max}$.

(c) After the rebounding off of the spring, the block slides up a frictionless ramp. How high will the block go?

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)?