Practice Exam #3

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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 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 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 3: Two pendulum bobs of unequal mass are suspended from the same fixed point by strings of equal length. The lighter bob is drawn aside and then released so that it collides with the other bob upon reaching the vertical position. The collision is elastic. What quantities are conserved during the collision?

(a) Both kinetic energy and momentum of the system.

(b) Only kinetic energy.

(c) Only momentum.

(d) Speed of lighter bob.

(e) None of the above.

Question 4: 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 $h = 1$ 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 5: 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?

Question 6: Two large barges are moving in the same direction in still water. Barge 1 has a speed of 10 km/h and barge 2 has a speed of 20 km/h. While they are passing each other, coal is shoveled from barge 1 to barge 2 at a rate of 1000 kg/min. How much additional force must be applied by the engines so that neither ship changes speed? Do the calculation for both ships! Ignore friction, and assume the shoveling is perfectly sideways.

(a) Barge 1—

(b) Barge 2—

Extra Credit: Two rockets are racing from the sun to Venus. They travel in a straight line and both start from rest. Rocket A is twice as heavy as rocket B. If their accelerations are $a_A = g$ and $a_B = 2a_A = 2g$, find

(a) the center of mass of the two rockets as a function of time;

(b) the velocity of the center of mass as a function of time;

(c) the acceleration of the center of mass as a function of time.