As a student at NJIT I will conduct myself in a professional manner and will comply with the provisions of the NJIT Academic Honor Code. I also understand that I must subscribe to the following pledge : On my honor, I pledge that I have not violated the provisions of the NJIT Academic Honor Code.

The exam is closed book and closed notes.

Circular motion: $a_c = \frac{v^2}{R}$; $F_{net} = ma$; **Weight:** $F_g = mg$, ; $g = 9.8\ m/s^2$; $P_{avr} = \frac{W}{\Delta t}$

Kinetic energy: $K = \frac{1}{2} m v^2$; **Potential energy:** $U_g = mgy$ $E_i = E_f$ $E = U+K$

Rotational motion: $\theta = \frac{s}{r}$; 1 rev = 2π rad; $v = \omega r$; $a_t = \alpha r$; $a_r = \frac{v^2}{r} = \omega^2 r$;

$\omega = \omega_0 + \alpha t$; $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$; $2\theta\alpha = \omega^2 - \omega_0^2$ $K = \frac{1}{2} I\omega^2$ $\tau = r \times F$; $\tau = rF\sin\phi$;

$\Sigma\tau = I\alpha$; $I_{point\ mass} = mr^2$ $I_{disk} = \frac{1}{2} mR^2$ $I_{cyl} = \frac{1}{2} mR^2$ $I_{pipe} = \frac{1}{2} m\left(R_{out}^2 + R_{in}^2\right)$

$I_{hoop} = mR^2$ $I_{rod(center)} = \frac{1}{12} mL^2$ $I_{rod(end)} = \frac{1}{3} mL^2$ $I_{ball} = \frac{2}{5} mR^2$ $I_{shell} = \frac{2}{3} mR^2$

$I = I_{com} + MD^2$ **work:** $W = \tau\theta$; $K = \frac{1}{2} I\omega^2$ $W = \frac{1}{2} I\omega_f^2 - \frac{1}{2} I\omega_i^2$ $P = \frac{dW}{dt}$ $P_{avr} = \frac{W}{\Delta t}$

Rolling: $v_{com} = R\omega$ $K = \frac{1}{2} I\omega^2 + \frac{1}{2} m v_{com}^2$ $\tau = f_s R$ $F_{s,max} = \mu_s Fn$

Incline: $F_{gx} = mg\sin\theta$ $F_{gy} = mg\cos\theta$

Angular momentum: $L_{point\ mass} = m\ r \times v$ $L = mrv\sin\theta$; $L = m(r_x v_y - r_y v_x)k$ $L = I\omega$

$L_I = L_f$ $I_1\omega_1 = I_2\omega_2$ $x_{com} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$ $y_{com} = \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2}$

NAME _____SCORE_____

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1. A 3.0-kg ball with an initial velocity of (4**i** + 3**j**) m/s collides with a wall and rebounds with a velocity of (–4**i** + 3**j**) m/s. What is the impulse exerted on the ball by the wall?

A) +24**i** N s
B) –24**i** N s
C) +18**j** N s
D) –18**j** N s
E) +8.0**i** N s

2. An 80-g particle moving with an initial speed of 50 m/s in the positive *x* direction strikes and sticks to a 60-g particle moving 50 m/s in the positive *y* direction. What is the magnitude of the velocity of the composite system after the collision?

A) 36 m/s
B) 50 m/s
C) 75 m/s
D) 86 m/s
E) 11 m/s

3. A merry-go-round rotates from rest with an angular acceleration of 1.56 rad/s^2. How long does it take to rotate through the first 2 rev?

A) 2 s
B) 4 s
C) 6 s
D) 8 s
E) 10 s

4. A wheel, with radius R = 0.5 m, initially has an angular velocity of 2.5 rev/s, and is slowing down at a rate of 2 rad/s^2. By the time it stops spinning about its center, what distance will a point on the outer rim have traveled?

A) 12 m
B) 18 m
C) 24 m
D) 31 m
E) 47 m

5. A uniform cylinder of radius *R*, mass *M* , and length *L* rotates freely about a horizontal axis parallel and tangent to the cylinder, as shown below. The moment of inertia of the cylinder about this axis is

A) $\frac{1}{2}MR^2$.

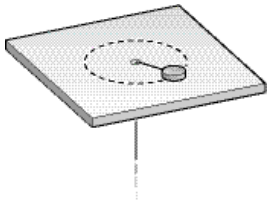
B) $\frac{2}{3}MR^2$.

C) MR^2

D) $\frac{3}{2}MR^2$**.**

E) $\frac{7}{5}MR^2$.

6. A puck on a frictionless air hockey table has a mass of 0.5 kg and is attached to a cord passing through a hole in the surface as in the figure.The puck is revolving at a distance 2.0 m from the hole with an angular velocity of 0.40 rev/s. What is the kinetic energy of the puck?



A) 2.4 J
B) 4.8 J
C) 6.3 J
D) 12.6 J
E) 18.4 J

7. A 2-kg object moving to the right with velocity 5 m/s collides with a 3-kg object which is initially at rest. After the collision, the 3-kg object has a velocity vector $\boldsymbol{v} = \boldsymbol{i} - \boldsymbol{j}$. What is the speed of the 2-kg object after the collision?

A) 0.8 m/s
B) 1.8 m/s
C) 2.8 m/s
D) 3.8 m/s
E) 4.8 m/s

8. If 15 J of potential energy are stored in a spring which has been compressed by 2 cm from its relaxed length, how much force will this spring exert if it is stretched by 4 cm from its relaxed length?

A) 500 N
B) 3000 N
C) 7500 N
D) 75,000 N
E) None of the Above

9. A mass of 10 kg is attached to the spring in problem 8. The spring is compressed by 2 cm and is released. When the spring reaches its equilibrium position, what is the speed of the 10-kg mass?

A) 1 m/s
B) 1.7 m/s
C) 2 m/s
D) 2.7 m/s
E) 3 m/s

10. A toy car is on a small indoor track, which is 100-m in circumference. The car starts from rest, accelerates uniformly, and after 5 seconds reaches a point halfway around the circle. At this time, what is the magnitude of the car's acceleration?

A) 4 m/s
B) 9 m/s
C) 16 m/s
D) 25 m/s
E) >25 m/s

11. A 2-kg block starts from rest at the top of a 10-m long ramp inclined at 45 deg to the horizontal. The block is released and begins to slide down the ramp. At the bottom of the ramp the block has a speed of 9 m/s. What is the coefficient of friction between the block and the ramp?

A) 0.12
B) 0.22
C) 0.32
D) 0.42
E) 0.52

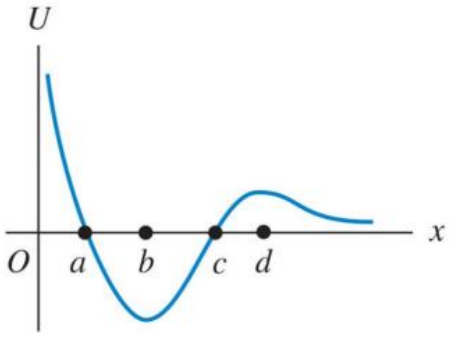
12. A 4-kg ball moving to the right at 12 m/s collides elastically with a 2-kg ball moving to the left at 6 m/s. What are the speeds of the 4-kg and the 2-kg balls after the collision?

A) 4 m/s and 10 m/s
B) 6 m/s and 12 m/s
C) 12 m/s and 6 m/s
D) 8 m/s and -8 m/s
E) 10 m/s and -4 m/s

13. A 2-kg block is placed at the top of a 5-m high, frictionless ramp and is released from rest. At the bottom of the ramp the 2-kg block collides with a 1-kg block that is initially at rest. The blocks stick together. What is the velocity of the blocks after the collision?

A) 3.3 m/s
B) 6.6 m/s
C) 9.9 m/s
D) 10.10 m/s
E) There is not enough information given

14. A potential energy function is given below. At what point would an object experience a force in the positive x direction?



A) a
B) b
C) c
D) d
E) in the region from 0 to a, and from c to infinity

15. A 3-kg box is moving at 6.0 m/s atop a hill that is 5.0 m above a flat frictionless surface. It descends the hill (also frictionless) and at the bottom of the hill contacts an ideal spring, which compresses 1.53 m before stopping. What is the spring constant k ?

A) 172 N/m
B) 225 N/m
C) 344 N/m
D) 450 N/m
E) 980 N/m

16. A 2-kg box is released from rest from the top of a 5-m-high frictionless ramp. At the bottom of the ramp the box has an elastic collision with an 8-kg box that is initially at rest. The 2-kg box bounces off the 8-kg box and goes back up the ramp. To what height does the 2-kg block return up the ramp before coming to rest?

A. 0.4 m
B. 0.8 m
C. 1.0 m
D. 1.8 m
E. 2.5 m