Physics 105 Sample Exam 3

Hatch 2-2427, Hess 2-2108

3 hour time limit. No books or notes.

Please write your CID_______

$\langle v \rangle = \dfrac{\Delta x}{\Delta t}$

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$v = v_o + a\,t$

$x = x_o + \frac{1}{2}(v_o + v)\,t$

$x = x_o + v_o t + \frac{1}{2} a\,t^2$

$v^2 = v_o^2 + 2a\,(x - x_o)$

If $ax^2 + bx + c = 0$, $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$g = 9.80\ m/s^2$

$\Sigma F = ma$ $w = mg$ $f_s \le \mu_s N$ $f_k = \mu_k N$

$W_{net} = KE_f - KE_i$

$KE_i + PE_i = KE_f + PE_f$

$KE_i + PE_i + W_{nc,in} = KE_f + PE_f + W_{nc,out}$

$W = F\cos\theta\, d$ $KE = \frac{1}{2} mv^2$ $PE = mgh$

$PE = \frac{1}{2} kx^2$ $F = -kx$ $P = W/t = Fv\cos\theta$

$p = mv$

$F\,\Delta t = \Delta p = m\mathbf{v}_f - m\mathbf{v}_i$

$x_{cm} = (\Sigma x_i m_i)/M$

$v_{cm} = (\Sigma v_i m_i)/M$

$\mathbf{F}_{ext} = M\,\mathbf{a}_{cm}$

$\mathbf{p}_i = \mathbf{p}_f$

$\langle \omega \rangle = \Delta\theta/\Delta t$

$\langle \alpha \rangle = \Delta\omega/\Delta t$

$\Delta s = r\Delta\theta$

$v = r\omega$

$a_t = \Delta|v|/\Delta t = r\alpha$

$a_c = v^2/r = r\omega^2$

$\Sigma F_c = m\,a_c$

$\omega = \omega_o + \alpha t$

$\Delta\theta = \frac{1}{2}(\omega_o + \omega)t$

$\Delta\theta = \omega_o t + \frac{1}{2}\alpha t^2$

$\omega^2 = \omega_o^2 + 2\alpha\Delta\theta$

$F = GMm/r^2$

$PE = -GMm/r$

$T^2 = (4\pi^2/GM)\,r^3$.

$G = 6.67 \times 10^{-11}\ N\cdot m^2/kg^2$

$R_{earth} = 6.38 \times 10^6\ m$

$M_{earth} = 5.98 \times 10^{24}\ kg$

$M_{sun} = 1.99 \times 10^{30}\ kg$

$\tau = F_\perp r = F r_\perp$

$\Sigma F = 0$

$\Sigma\tau = 0$

$I = \Sigma m_i r_i^2$

$I_{sphere} = (2/5)\,MR^2$

$I_{hoop} = MR^2$

$I_{disk} = \frac{1}{2} MR^2$

$I_{rod\ (center)} = (1/12)\,ML^2$

$I_{rod\ (end)} = (1/3)\,ML^2$

$KE_{rot} = \frac{1}{2} I\omega^2$

$\Sigma\tau = I\,\alpha$

$L = p_\perp r = I\omega$

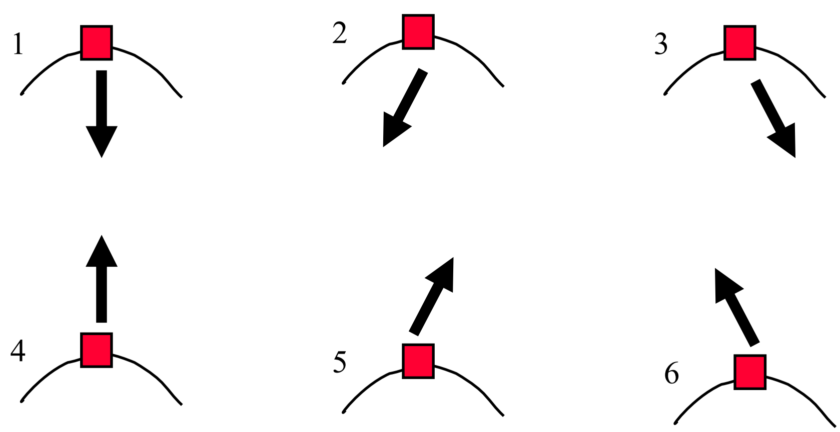
Note: the format of the exam you will take is the same as the previous 2: use 2nd significant digit, and keep four digits.

On the real exam, some of the problems will have ranges provided.

A blue bumper car of mass 80 kg traveling right at 3 m/s hits a red bumper car of mass 120 kg moving left at 4 m/s. After the collision, the blue bumper car travels backwards at 2 m/s, and the red bumper car must be going [1S]_________ m/s to the [2?]____________ 1) right 2) left. In this collision, the kinetic energy change during the collision was [3S]__________ J.

A boy on a skateboard with total mass 60 kg is traveling 10 m/s. A friend of mass 40 kg, who has no initial velocity, steps on the board as he passes by, and they travel together. Their speed right after the friend steps on is [4S]__________ m/s.

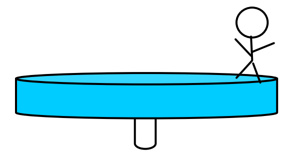
A red car moves clockwise around a circle at constant speed at the instant shown. The total acceleration vector (or net force) is [5?]_______ (choose one picture below. If a=0, mark 0). If the car is moving clockwise and speeding up, the total acceleration vector is [6?]_______ (choose one picture below. If a=0, mark 0).



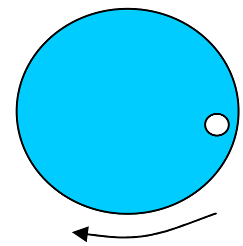
A grinding wheel has a moment of inertia of 0.12 kg m^2. It has an angular acceleration of 5 rad/s^2. If it accelerates constantly from rest, in 15 seconds it will have turned [7S]_________ revolutions. (Careful with units). The grinding wheel is a solid disk of radius 8 cm. It must have a mass of [8S]_________ kg. The torque that the motor puts on it to accelerate it is [9S]_____ Nm. When it is going fast enough, you turn off the motor. You now grind a piece of steel, and because of this it decelerates at 0.3 rad/s^2. The frictional force between the steel and the wheel is [10S]_____ N.

A spaceship of mass 3000 kg is launched from the earth to a circular orbit in such a way that the speed of the space ship in orbit is 4000 m/sec. The radius of the orbit measured *from the center of the earth* is [11S]___________ m. While in orbit, the astronauts inside the ship [12?]________ 1) are weightless 2) are in free-fall

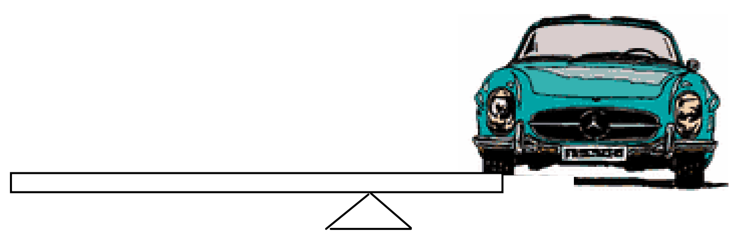
A merry-go round is spinning with a boy at the edge.
When the boy walks to the center the kinetic energy of the system [13?]_______ 1) increases 2) decreases 3) stays the same. The rotational speed [14?]_________ 1) increases 2) decreases 3) stays the same



A merry-go round is spinning with a boy at the edge. He slips off when he steps on a frictionless icy part of the merry-go-round. The rotational speed of the merry go round [15?]_________ 1) increases 2) decreases 3) stays the same



A man is trying to lift his car with a steel lever. The man's weight is 500 N, and the car's weight is 7000 N. He lifts only *two wheels* slightly off the ground. The other two are still on the ground. The fulcrum (pivot point) is 1 meter from the car's tires. If he uses all his weight and stands on the end of the lever, the *total* length of the steel lever must be at least [16S]_______ m to lift the car. Neglect the weight of the lever.

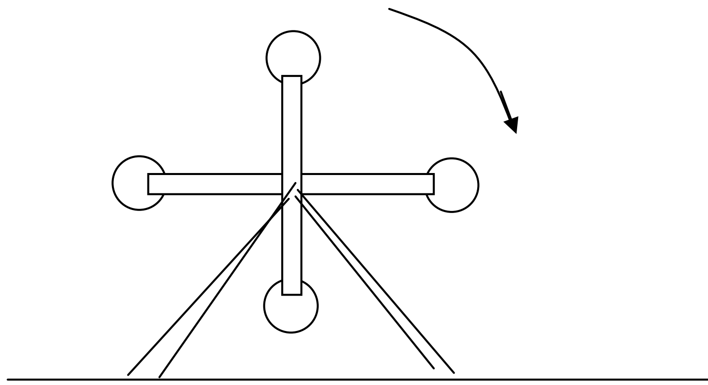


A round object of radius 0.4 m, mass 8 kg and moment of inertia 0.6 kg m^2 is rolling on the ground without slipping, and the speed of its center of mass is 9 m/s. The *total* kinetic energy of the object is [17S]__________ J. The round object rolls up an inclined plane without slipping and stops. A block, with the same mass and traveling at the same speed also slides without friction up the inclined plane and stops. The object that ends up highest on the inclined plane is [18?]__________ 1) the rolling object 2) the block 3) neither…same final height .

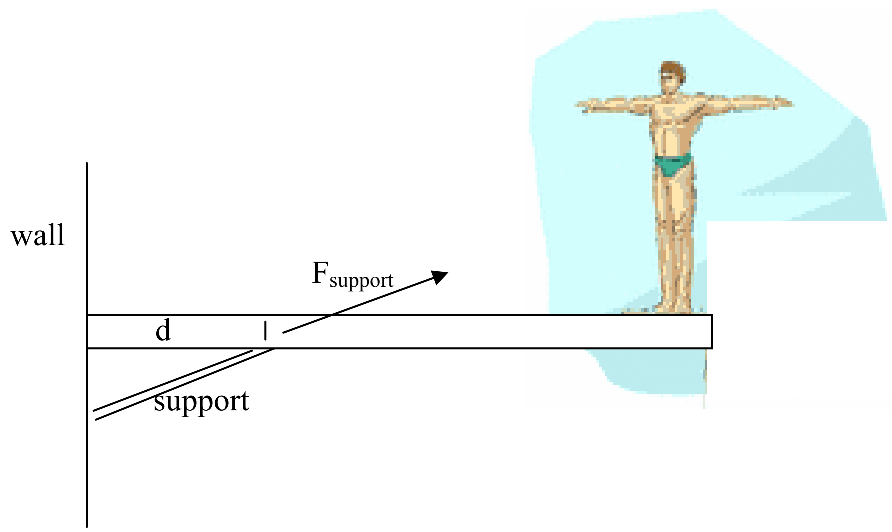
A firecracker at rest explodes into two pieces. A large piece moves to the right. A small piece moves to the left. Which piece moves faster [19?] _________ 1) the large piece 2) the small piece 3) the same speed. After the explosion, the center of mass of the two pieces combined [20?]__________ 1) is moving right 2) is moving left 3) is not moving.

The further a satellite is from the earth, the rotation period gets [21?]________ 1) shorter 2) longer 3) doesn't change

A carnival ride has four cages on rods, rotating in a vertical plane. All the cages move at the same speed. If the tension in the rods is too great, a cage will break off. If the ride rotates too fast, the cage most likely to break off will be the one on the [22?]________ 1) left 2) right 3) top 4) bottom 5) none; all equally likely



A diver stands on the end of a board weighing 800 N that is 4 meters long. The support below the board puts a force of 6000 N on the board a distance d=1.2 m from the wall, along the line of the support, shown by the arrow, 30 degrees above the horizontal. The torque exerted by the support on the board about its left end is [23S]________ Nm. The torque exerted by the weight of the beam on the board about its left end is [24S]________ Nm. The weight of the diver must be [25S]______ N.



The disk of mass m has a rope wrapped several times around its edge. The falling weight has mass M. As the system accelerates, the disc rotates about its center. There is no slipping of the rope. For m=30 kg, and M=50 kg, R= 20 cm, the acceleration of the mass M is [26S]______ m/s^2.