Your Name: ____________________________ TEST #3

Print clearly.

On the Scantron, fill out your student ID, leaving the first column empty and starting in the second column. Also write your name, class time (11:30 or 12:30), and "Test 3" at the bottom. There are 20 equally-weighted questions on this test. There is only one correct answer per question. **Mark your answer on the Scantron.** The second to last page is blank for extra space if needed. The formulas are on the last page so you can separate it for easy access. The key will be posted online **after** all make-up tests are completed.

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1. A 2m-radius wheel rotates with constant angular acceleration of 3.50 rad/s^2. If the angular speed of the wheel is 2.00 rad/s at t = 0, what is the angular speed of the wheel at t = 2.00s?

a) 7.00 rad/s b) 9.00 rad/s c) 11.0 rad/s d) 16.0 rad/s e) 17.0 rad/s

2. For the wheel from the previous problem, what was the ball's *initial* tangential (linear) velocity?

a) 0.00 m/s b) 2.00 m/s c) 2.20 m/s d) 4.00 m/s e) 7.00 m/s^2

3. A boy and a girl are riding on a merry-go-round that is turning at a constant rate. The boy is near the edge, and the girl is closer to the center. Who has the greater angular velocity, ω?

a) The girl
b) The boy
c) Both have zero angular velocity
d) Both have the same non-zero angular velocity

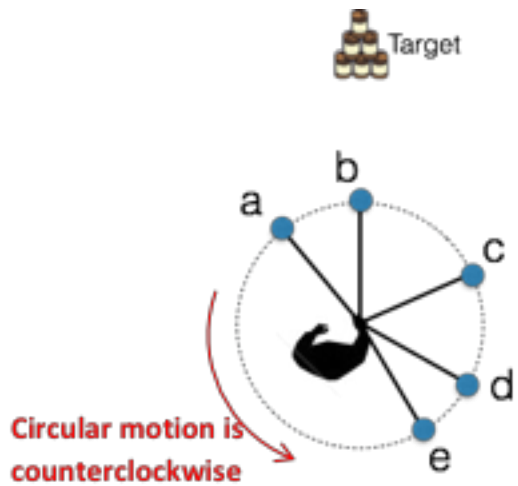
4. When an object experiences uniform circular motion, the direction of the net force on the object is

a) perpendicular to the acceleration
b) parallel to the velocity
c) away from the center of the circular path
d) toward the center of the circular path
e) there is no net force since it is uniform motion

5. You and your physics buddy decide to go to the local science-themed amusement park. You're too chicken to go on the roller coaster, but there's a sign nearby: "Find the acceleration, Win $100!" The cart with passengers weighs 900kg and the radius of the circular loop is 10m. You need to determine the centripetal acceleration as the roller coaster hits the lowest part in the loop. You estimate the tangential (linear) velocity of the cars at that point to be about 30 m/s. What answer do you submit to the prize table?

a) 10 m/s^2 b) 20 m/s^2 c) 45 m/s^2 d) 70 m/s^2 e) 90 m/s^2

6. At the next booth, you need to stand in a set position and hit a target with a ball on a string. Assuming you give the ball enough velocity to reach the target before it hits the ground, at what point do you let go of the string, given the diagram below?



7. After a lot of corndogs, crazy rides, and way too many g's, you're stumbling towards the amusement park exit. You decide to try one more booth. Your goal is to make a tub of fresh water overflow by putting an object in the tub. The volume of water you need to displace is 2.30 m^3, and there are a few objects to choose from, each with a volume 2.31 m^3. Which should you pick?

a) A mesh sack of apples, density 716 kg/m^3
b) The pumace stone, density 250 kg/m^3
c) A big ice cube, density 913 kg/m^3
d) Cranberry sauce, density 1150 kg/m^3
e) Any of the above except the ice

8. After a factory worker turns his machine on, a gear in the machine experiences a constant torque of 300 N m, spinning it up from rest. What is its angular momentum after 5 seconds?

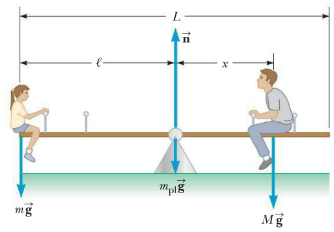
a) 7500 kg m^2/s b) 1500 kg m^2/s c) 588 kg m^2/s d) 60 kg m^2/s e) 12 kg m^2/s

9. Two children are pushing with opposing tangential force on a horizontal spinning playground ride of radius 2 m. The ride's moment of inertia is 250 m^2 kg. One child pushes clockwise with a force of 5 N and the other is stronger, pushing counter-clockwise with 20 N. What is the magnitude of the ride's net angular acceleration?

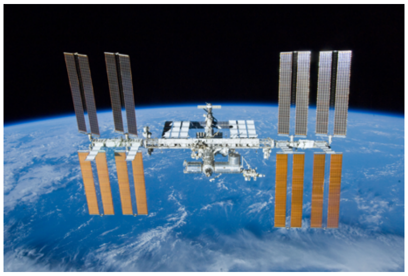
a) 0.12 rad/s^2 b) 0.24 rad/s^2 c) 0.31 rad/s^2 d) 0.66 rad/s^2 e) 1.52 rad/s^2

10. Two kids are sitting on a 2.00 m long see-saw that rotates about its center point. The first kid is 30 kg and sits at the end of the see-saw. The second kid is 42 kg. How far from the center must the second kid sit to balance the see-saw (so the see-saw is in equilibrium)?

a) 0.71 m b) 1.0 m c) 0.29 m d) 0.17 m e) 1.3 m



11. The Earth has a mass of 5.97×10^{24} kg. The International Space Station orbits Earth at 250 km, and feels a gravitational pull of about 3.36×10^{6} N. What is the mass of the International Space Station (pictured below)? The radius of Earth is 6371 km.



a) 1260 kg
b) 4.56×10^{3} kg
c) 1.26×10^{4} kg
d) 3.70×10^{5} kg
e) 4.5×10^{6} kg

12. A disk ($I = ½ MR^2$) and a sphere ($I=2/5 MR^2$) of equal mass and radius are rolling with the same angular velocity. Which has the greater rotational kinetic energy?

a) The disk.

b) The sphere.

c) They both have the same rotational kinetic energy.

d) Not enough information to determine.

13. A hoop with mass 1.5 kg and radius, $r = 0.15$ m starts at rest at the top of a 2.0 m (vertical height) ramp. What is the angular speed, ω, of the hoop at the bottom of the ramp? The moment of inertia of a hoop is $I = MR^2$.

a) 25 rad/s b) 30 rad/s c) 38 rad/s d) 42 rad/s e) 47 rad/s

14. A 200 kg load is hung on a wire of length 4.00 m, cross-sectional area 0.200×10^{-4} m^2, and Young's modulus 8.00×10^{10} N/m^2. What is its increase in length?
a) 1.35 mm b) 2.28 mm c) 3.60 mm d) 4.90 mm e) 5.12 mm

15. A woman is snorkeling near the surface of the ocean and dives down 5.00 m to see some fish. What is the change in pressure that she experiences? The density of sea water is 1.025×10^3 kg/m^3.
a) 1.04×10^3 Pa
b) 2.14×10^4 Pa
c) 5.02×10^4 Pa
d) 7.12×10^4 Pa
e) 3.12×10^5 Pa

16. A large balloon is filled with helium gas until its volume is 325 m^3. Assume the density of air is 1.29 kg/m^3 and the density of helium is 0.179 kg/m^3. Calculate the buoyant force of the air acting on the balloon.

a) 0.570 kN b) 1.00 kN c) 1.57 kN d) 2.50 kN e) 4.11 kN

17. The aorta has a cross-sectional area of 1.8 cm^2 and then branches to form a large number of capillaries with a combined cross-sectional area of 2.9×10^3 cm^2. If the flow speed in the aorta is 33 cm/s, what is the flow speed in the capillaries?

a) 2.0×10^{-2} cm/s b) 2.3×10^{-2} cm/s c) 45 cm/s d) 1.8×10^2 cm/s e) 4.3×10^2 cm/s

18. You've been asked to design the plumbing system for an office building and want to make sure you get strong enough pipes. Water at a pressure of 3.85×10^5 Pa at street level will flow into the building at a speed of 0.06 m/s through a pipe with a cross-sectional area of 8.0×10^{-3} m^2. The single pipe tapers down to a 3.0×10^{-3} m^2 area pipe by the top floor, 20 m above. If you first determine the flow velocity of the pipe on the top floor, you can determine the pressure in the pipe on the top floor. What is the pressure in the pipe on the top floor?

a) 1.9×10^5 Pa   b) 2.1×10^5 Pa   c) 3.80×10^5 Pa   d) 3.85×10^5 Pa   e) 7.70×10^6 Pa

19. The New River Gorge bridge in West Virginia is a 518-m-long steel arch. How much will its length change between temperature extremes −21°C and 30°C? The linear coefficient of steel is 11×10^{-6} $(°C)^{-1}$.

a) 5.1 cm b) 15 cm c) 29 cm d) 31 cm e) 51 cm

20. Two blocks differ in temperature by 20° C. By how much does their temperature differ in the Kelvin scale?

a) 0 K b) 20 K c) 25 K d) 68 K e) 68° F

Possibly Useful Information (**bold** indicates a vector)

$v = v_o + a\,t$ $\Delta x = v_o t + \frac{1}{2} a\,t^2$ $v^2 = v_o^2 + 2\,a\,\Delta x$ 1 in = 2.54 cm

$W = m\,g$ $g = 9.8\ m/s^2$ $f_k = \mu_k\,n$ $f_s \le \mu_s\,n$

$\sin\theta$ = opposite/hyp $\cos\theta$ = adjacent/hyp $\tan\theta$ = opposite/adj $a^2 + b^2 = c^2$

1 kg = 2.2 pounds 1 m = 3.28 ft quadratic: $ax^2+bx+c=0$ $x=(-b\pm(b^2-4ac)^{\wedge}\frac{1}{2})/2a$

Newton's 1st Law: Every object continues in its state of rest, or of constant speed in a straight line, until a nonzero net force acts on it.

Newton's 2nd Law: net **F** = m **a**

Newton's 3rd Law: When one object exerts a force on a second object, the second object exerts an equal and opposite force on the first object.

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Work = $F_{||}\Delta x$ = (component of force in the direction of displacement) (displacement)

Kinetic Energy: $KE = \frac{1}{2} m\,v^2$ Power = Work/time

Work-Energy Theorem $W_{net} = W_{nc} + W_c = \Delta KE$

Gravitational Potential Energy: GPE = mgy where y is vertical position

Work done by gravity: $W_g = -\Delta GPE$

$W_{nc} + KE_i + PE_i = KE_f + PE_f$ where W_{nc} is work done by frictional forces

$KE_i + PE_i = KE_f + PE_f$ if there is no friction

Momentum: $\mathbf{p} = m\,\mathbf{v}$ **I** (impulse) = change in momentum = **F** Δt

Conservation of momentum: $m_1\mathbf{v}_{1i} + m_2\mathbf{v}_{2i} = m_1\mathbf{v}_{1f} + m_2\mathbf{v}_{2f}$

Elastic collision: $v_{1i}-v_{2i} = -(v_{1f}-v_{2f})$ Perfectly inelastic collision: $m_1v_{1i} + m_2v_{2i} = (m_1+ m_2)v_f$

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$\theta = s/r$ $\omega = \Delta\theta/\Delta t$ $\alpha = \Delta\omega/\Delta t$ $v = r\,\omega$ $a_T = r\,\alpha$ $a_C = v^2/r = r\,\omega^2$

$\omega = \omega_o + \alpha\, t$ $\Delta\theta = \omega_o t + ½\,\alpha\, t^2$ $\omega^2 = \omega_o^2 + 2\,\alpha\,\Delta\,\theta$ $G = 6.673\mathrm{x}10^{-11}$ N m^2/kg^2

$F = G\, m_1 m_2/r^2$ $\tau = r\, F_\perp$ $\tau_{net} = I\,\alpha = \Delta L/\Delta t$ $I = \Sigma m r^2$

$L = I\,\omega$ $KE_{rot} = ½\, I\,\omega^2$ Conservation of angular momentum: $L_i = L_f$

$\rho = M/V$ $P = F/A$ stress=elastic modulus x strain $F/A = Y\,\Delta L/L_0$ (Young's modulus)

$F/A = S\Delta x/h$ (shear modulus) $\Delta P = -B\,\Delta V/V$ (bulk modulus)

density of fresh water = 1.00×10^3 kg/m^3

$P = P_0 + \rho g h$ $F_B = B = \rho V g$ $A_1 v_1 = A_2 v_2$ $P_1 + ½\,\rho v_1^2 + \rho g y_1 = P_2 + ½\,\rho v_2^2 + \rho g y_2$

$T_C = T - 273.15$ $T_F = 9/5\; T_C + 32$

$\Delta L = \alpha\, L_0\, \Delta T$ $\Delta A = \gamma\, A_0\, \Delta T$ $\Delta V = \beta\, V_0\, \Delta T$