Practice test #3B

1. A wheel rotates with a constant angular acceleration of 3.50 rad/s². If the angular speed of the wheel is 2.00 rad/s at t = 0, how many revolutions does the wheel go through after 3.00 s?
   a) 2.50 rev  b) 3.46 rev  c) 21.8 rev  d) 34.2 rev  e) 11.6 rev

2. 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 centripetal acceleration?
   a) The girl
   b) The boy
   c) Both have zero centripetal acceleration
   d) Both have the same non-zero centripetal acceleration
3. A Ferris wheel starts from rest and takes 15 seconds to get up to speed. If the Ferris wheel uniformly accelerates over these 15 seconds and ends up with an angular speed of 2 revolutions per minute what is its angular acceleration?

   a) 0.209 rad/s²   b) 1.07 rad/s²   c) 0.098 rad/s²   d) 0.052 rad/s²   e) 0.014 rad/s²

4. An athlete swings a 5.40-kg ball horizontally on the end of a rope. The ball moves in a circle of radius 0.650 m at an angular speed of 4.84 rad/s. What is the ball’s centripetal acceleration?

   a) 3.15 m/s²   b) 6.45 m/s²   c) 9.71 m/s²   d) 11.3 m/s²   e) 15.2 m/s²

5. Find the force of gravity that Earth exerts on an asteroid when the asteroid is at a point 4.00 x 10⁸ m from the center of the Earth. The asteroid has mass 1.00 x 10⁹ kg and Earth’s mass is 5.98 x 10²⁴ kg.

   a) 1.72 x 10⁶ N   b) 2.49 x 10⁶ N   c) 3.75 x 10⁸ N   d) 9.98 x 10¹⁴ N
6. Two objects attract each other gravitationally. When their separation distance is cut in half (i.e., they move closer by a factor of two), the gravitational force is
   a) cut to one fourth  b) cut in half  c) doubled  d) quadrupled

7. A wrench is fitted to a stuck bolt and makes an angle of 35° with respect to the horizontal. The wrench is 0.5 m long and a force of 100 N is applied vertically downward at the end of the wrench farthest from the bolt. How much torque is applied to the bolt by this force?
   a) 50 N m  b) 41.0 N m  c) 28.7 N m  d) 59.6 N m

8. Two balls have the same mass, M, and radius R. One ball is solid, with a moment of inertia, $I = \frac{2}{5} MR^2$, and the other ball is a hollow shell with moment of inertial, $I = \frac{2}{3} MR^2$. The balls are released from rest at the top of a ramp. Read the following statements (these statements are not the answer choices, those appear below the statements):
   1. The solid ball arrives at the bottom of the ramp before the hollow ball.
   2. The hollow ball arrives at the bottom of the ramp before the solid ball.
   3. The solid ball has a greater angular acceleration.
   4. The hollow ball has a greater angular acceleration.

   Which of the statements, 1–4, are true?
   a) 1 and 3  b) 1 and 4  c) 2 and 3  d) 2 and 4
9. A student sits on a stool holding his arms outstretched with a pair of weights in his hands. The moment of inertia of the student, weights, and stool is 2.25 kg m$^2$. The student is rotating with an angular speed of 4.99 rad/s. The student pulls his arms inward, causing him to spin at 6.24 rad/s. What is the moment of inertia after the student pulls in his arms?

a) 1.44 kg m$^2$  

b) 1.80 kg m$^2$  

c) 2.05 kg m$^2$  

d) 2.55 kg m$^2$  

e) 2.80 kg m$^2$

10. A spinning figure skater pulls his arms in as he rotates on the ice. As he pulls his arms in, what happens to his angular momentum L and kinetic energy K?

a) L and K both increase.

b) L stays the same; K increases.

c) L increases; K stays the same.

d) L and K both stay the same.

11. A plank 2.00 cm thick and 15.6 cm wide is firmly attached to the railing of a ship by clamps so that the rest of the board extends 2.00 m horizontally over the sea below. A man of mass 69.5 kg is forced to stand on the very end. If the end of the board drops by 4.20 cm because of the man's weight, find the shear modulus of the wood.

a) 6.32 x 10$^4$ Pa  

b) 1.04 x 10$^5$ Pa  

c) 6.32 x 10$^6$ Pa  

d) 1.04 x 10$^7$ Pa  

e) 6.32 x 10$^7$ Pa
12. Two metal wires, one made of copper \(Y_{copper} = 7.0 \times 10^{10} \text{ Pa}\) and one made of steel \(Y_{steel} = 20 \times 10^{10} \text{ Pa}\), are initially the same length with the same cross sectional area. A 10 kg mass is hung from each of these two wires. Which of the following statements is true?

a) The steel wire will be stretched more than the copper wire.
b) The copper wire will be stretched more than the steel wire.
c) Both wires will be stretched by the same amount because they started with the same length.
d) None of the above.

13. The pressure at the bottom of a glass filled with water \(\rho = 1000 \text{ kg/m}^3\) is \(P\). The water is poured out and the glass is filled with ethyl alcohol \(\rho = 806 \text{ kg/m}^3\). The pressure at the bottom of the glass is now

a) smaller than \(P\).
b) equal to \(P\).
c) larger than \(P\).
d) unable to determine.

14. Two blocks have the same size but are made of different materials. One block floats and the other sinks in water. Which statement is true?

a) The buoyant force on the floating block is larger than the buoyant force on the sinking block.
b) The buoyant force on the sinking block is larger than the buoyant force on the floating block.
c) The buoyant forces on the floating and sinking blocks are equal because the blocks are the same size.
15. A raft is constructed of wood having a density of \(6.00 \times 10^2\) kg/m\(^3\). Its surface area is 5.70 m\(^2\) and its volume is 0.60 m\(^3\). When the raft is placed in fresh water, to what depth, \(h\), is the bottom of the raft submerged?

   a) 23.7 mm  
   b) 36.8 mm  
   c) 49.6 mm  
   d) 63.2 mm  
   e) 70.3 mm

16. A pipe of radius 0.02 m has water flowing through it at a speed of 12 m/s. If the pipe were to increase in radius to 0.05 m what will be the new speed of the water?

   a) 1.92 m/s  
   b) 4.80 m/s  
   c) 12 m/s  
   d) 30 m/s  
   e) 75 m/s
17. A piece of pipe of uniform cross sectional area feels a water pressure of $2.00 \times 10^5$ Pa at point A. What is the pressure at a point that is 5 m above point A?

a) $9.33 \times 10^4$ Pa  

b) $1.04 \times 10^5$ Pa  

c) $2.00 \times 10^5$ Pa  

d) $1.51 \times 10^5$ Pa  

e) $1.86 \times 10^6$ Pa

18. An incompressible fluid flows from a wide piece of pipe at point A to a relatively thin piece of pipe at point B as shown. How does the pressure at point A compare to that at point B?

a) The pressure at point A is higher than that at B

b) The pressure at point A is lower than that at B

c) The pressure at point A is the same as that at B

d) Not enough information is given to answer this question
19. Two blocks differ in temperature by 15°C. By how much does their temperature differ in the Kelvin scale?
   a) 0 K    b) 8.3 K    c) 15 K    d) 27 K    e) 15°F

20. A manhole cover has a radius of 0.300 m on a day when the temperature is 12°C. On another day the temperature has increased to 25°C and the radius of the manhole cover has increased to 0.301 m what is the coefficient of area expansion (γ) for the manhole cover?
   a) 4.39 x 10^{-4} 1/°C
   b) 5.14 x 10^{-4} 1/°C
   c) 9.85 x 10^{-4} 1/°C
   d) 8.62 x 10^{-4} 1/°C
   e) 2.34 x 10^{-4} 1/°C
Possibly Useful Information (bold indicates a vector)

\[ \mathbf{v} = \mathbf{v}_0 + \mathbf{a} \quad \Delta x = v_0 t + \frac{1}{2} a t^2 \quad v^2 = v_0^2 + 2 a \Delta x \quad 1 \text{ in} = 2.54 \text{ cm} \]

\[ W = m \, g \quad g = 9.8 \text{ m/s}^2 \quad f_k = \mu_k \, n \quad f_s \leq \mu_s \, n \]

\[ \sin \theta = \frac{\text{opposite}}{\text{hyp}} \quad \cos \theta = \frac{\text{adjacent}}{\text{hyp}} \quad \tan \theta = \frac{\text{opposite}}{\text{adj}} \quad a^2 + b^2 = c^2 \]

\[ 1 \text{ kg} = 2.2 \text{ pounds} \quad 1 \text{ m} = 3.28 \text{ ft} \quad \text{quadratic: } ax^2 + bx + c = 0 \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \]

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 \( \mathbf{F} = m \mathbf{a} \)

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.

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 = \( \mathbf{F} \Delta t \)

Conservation of momentum: \( m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f} \)

Elastic collision: \( v_{1f} - v_{2i} = -(v_{1i} - v_{2i}) \)

Perfectly inelastic collision: \( m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2)v_f \)
\[ \theta = \frac{s}{r} \quad \omega = \frac{\Delta \theta}{\Delta t} \quad \alpha = \frac{\Delta \omega}{\Delta t} \quad v = r \omega \quad a_T = r \alpha \quad a_C = v^2/r = r \omega^2 \]

\[ \omega = \omega_0 + \alpha t \quad \Delta \theta = \omega_0 t + \frac{1}{2} \alpha t^2 \quad \omega^2 = \omega_0^2 + 2 \alpha \Delta \theta \quad G = 6.673 \times 10^{-11} \text{ N m}^2/\text{kg}^2 \]

\[ F = G \frac{m_1 m_2}{r^2} \quad \text{PE}_{\text{Earth}} = -G M_E \frac{m}{r} \quad \tau = r F_\perp \quad \tau_{\text{net}} = I \alpha = \frac{\Delta L}{\Delta t} \quad I = \Sigma mr^2 \]

\[ L = I \omega \quad \text{KE}_{\text{rot}} = \frac{1}{2} I \omega^2 \quad \text{KE}_{\text{R}} + \text{KE}_{\text{T}} + \text{PE}_i = \text{KE}_{\text{R}} + \text{KE}_{\text{T}} + \text{PE}_f \]

Conservation of angular momentum: \( L_i = L_f \)

\[ \rho = \frac{M}{V} \quad P = \frac{F}{A} \quad \text{stress} = \text{elastic modulus} \times \text{strain} \quad F/A = Y \frac{\Delta L}{L_0} \text{ (Young’s modulus)} \]

\[ F/A = S \frac{\Delta x}{h} \text{ (shear modulus)} \quad \Delta P = -B \frac{\Delta V}{V} \text{ (bulk modulus)} \]

\[ \text{density of fresh water} = 1.00 \times 10^3 \text{ kg/m}^3 \quad \text{Area of a circle} = \pi r^2 \]

\[ P = P_0 + \rho gh \quad B = \rho V g \quad A_1 v_1 = A_2 v_2 \quad P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2 \]

\[ T_C = T - 273.15 \quad T_F = \frac{9}{5} T_C + 32 \]

\[ \Delta L = \alpha L_0 \Delta T \quad \Delta A = \gamma A_0 \Delta T \quad \Delta V = \beta V_0 \Delta T \]