INSTRUCTIONS:

This exam is longer than the one you will take in class. Here you will get an idea of the type of questions you may be asked in the actual exam.

1. A ladybug hangs on for dear life to the outer edge of a turntable that spins with constant angular speed. What can be said about the net force and net torque on the ladybug?
   (a) Both the net force and net torque are zero.
   (b) Neither the net force nor the net torque are zero.
   (c) The net force is zero and the net torque is not zero.
   (d) The net force is not zero and the net torque is zero.

   ANSWER[ ]

2. A wheel that is rotating at 33.3 rad/s is given an angular acceleration of 2.15 rad/s². Through what angle has the wheel turned when its angular speed reaches 72.0 rad/s?
   (a) 83.2 rad
   (b) 697 rad
   (c) 66.8 rad
   (d) 948 rad

   ANSWER[ ]

3. A solid disk is released from rest and rolls without slipping down an inclined plane that makes an angle of 25.0° with the horizontal. What is the speed of the disk after it has rolled 3.00 m, measured along the plane?
   (a) 3.53 m/s
   (b) 4.07 m/s
   (c) 5.71 m/s
   (d) 6.29 m/s

   ANSWER[ ]

4. The rotating systems shown in the figure differ only in that the two identical movable masses are positioned a distance \( r \) from the axis of rotation (left), or a distance \( r/2 \) from the axis of rotation (right). If you release the hanging blocks simultaneously from rest,
   (a) the block at left lands first.
   (b) the block at right lands first.
   (c) both blocks land at the same time.
   (d) it is impossible to tell which block reaches the bottom first.

   ANSWER[ ]
5. A mass hanging on the end of a spring executes motion characterized by \( y = (0.15m) \sin(24t) \), where \( y \) is the displacement from the equilibrium position and \( t \) is the time in seconds. At the time when \( y = -0.15 \) m

(a) the acceleration is maximum and the velocity is maximum.
(b) the acceleration and the velocity are both zero.
(c) the frequency is zero.
(d) the acceleration is maximum, and the velocity is zero.
(e) the acceleration is zero, and the velocity is maximum.

ANSWER[ ] (score) (4)

6. The distance from the feet to the heart for an individual is 1.20 m, and the density of blood is \( 1.06 \times 10^3 \) kg/m\(^3\). Find the difference in blood pressure between the level of the feet and the level of the heart.

(a) 1270 Pa
(b) \( 1.06 \times 10^9 \) Pa
(c) \( 1.25 \times 10^4 \) Pa
(d) 1.00 atm

ANSWER[ ] (score) (4)

7. When a block of wood of volume = 50 cm\(^3\) is floating on water, and a block of iron of the same volume is submerged at depth = \( h \), and sinking,

(a) both the iron and the wood displace their own weight of water.
(b) both the iron and the wood displace their own volume of water.
(c) both the iron and the wood experience the same buoyant force.
(d) the iron displaces its own volume of water and the wood displaces its own weight of water.
(e) the wood experiences a greater buoyant force than the iron.

ANSWER[ ] (score) (4)

8. The pressure inside a commercial airliner is maintained at 1 ATM (\( 10^5 \) N/m\(^2\)). What is the net outward force exerted on a 1 m \( \times \) 2 m cabin door if the outside pressure(at 10 km height) is 0.3 ATM?

(a) 140 N
(b) 1,400 N
(c) 14,000 N
(d) 140,000 N

ANSWER[ ] (score) (5)

9. When water freezes, it expands about 9 percent. What would be the pressure increase inside your automobile engine block if the water in there froze? (The bulk modulus of ice is \( 2 \times 10^9 \) N/m\(^2\), and 1 ATM = \( 10^5 \) N/m\(^2\)).

(a) 18 ATM
(b) 270 ATM
(c) 1800 ATM
(d) 2700 ATM

ANSWER[ ] (score) (5)
10. Betina is testing the strength of her biceps muscle by exerting a force on a test strap as shown in the diagram. The strap is 28 cm from the pivot point at the elbow, and her biceps muscle is attached at a point 5 cm from the pivot point. If the scale reads 18 N when she exerts her maximum force, what is the magnitude of the force exerted by the biceps? Begin by drawing a clear free-body diagram separate from the picture shown.
11. A block of mass $= M$ (kg) is supported by a massless string wound on a uniform cylinder, which has a mass $= 2M$ (kg), i.e., twice as massive. The radius of the cylinder $= R$ (m) and the axle about which the cylinder turns has no friction. The system, shown in the accompanying diagram, is released from rest.

(a) Draw a free body diagram for each mass, and write a Newton’s second law equation for each.

(b) Derive an expression for the linear acceleration of the hanging block in terms of $g$. 

(score) (8)

(score) (7)
12. A physics professor, holding two dumbbells, one in each hand, stands on a rotating platform. Initially, the physicist hold the dumbbells straight out at arm’s length. In this position, the moment of inertia of the physicist, the dumbbells and the platform is 35.0 kg·m² and the platform is rotating at 1.0 revolutions per second. When he pulls his arms in, the moment of inertia is reduced to 25.0 kg·m².

(a) Find the new angular velocity of the platform.

(b) Find the work done by the physicist when he pulled his arms in.
13. You have made a simple pendulum. The pendulum bob’s mass is exactly 1 kg. The length of the simple pendulum is exactly 1.75 meters.

(a) Find the period of this pendulum on the surface of the earth.

(b) Suppose you move this simple pendulum to the surface of the moon, where the pendulum bob weighs 1/6 as much as its weight on earth. What is the period for one complete small oscillation on the moon?

14. Archimedes determined that the king’s crown had a density of 11,300 $kg/m^3$ — definitely not gold. When this crown is hung from the end of a scale in air, it shows a weight of 147 N. When the same crown is hung from the same scale and immersed in a fluid, the scale indicates an apparent weight of 129 N. What is the mass density of this fluid?