Physics 53 Exam 3 Dr. Alward Monday, April 6, 2009

More difficult problems are marked with an asterisk (*).

1. A disc rotating about its axis at 40 rad/s begins at time t = 0 to accelerate at the rate of 5 rad/s^2. What will be the average angular velocity in rad/s between the times t = 3 s and t = 7 s?

(a) 45
(b) 55
(c) 65
(d) 75
(e) None of the above

2. The angular speed of an automobile engine increases from 1200 rev/min to 3000 rev/min in 12 seconds. How many revolutions does the engine make during this 12 s interval?

(a) 560
(b) 420
(c) 640
(d) 860
(e) None of the above

3. The angular acceleration of a wheel initially at rest at time is 4 rad/s^2. Through how many radians will the wheel rotate during the period of time from t = 1 s to t = 4 s?

(a) 20
(b) 30
(c) 40
(d) 60
(e) None of the above

4. The rotational inertia of a uniform rod of length L and mass M about its center is $ML^2/12$. What is the rotational inertia (in kg-m^2) of a meter stick whose mass is 0.56 kg, about an axis perpendicular to the stick and located 20 cm from the center?

(a) 0.54
(b) 0.29
(c) 0.21
(d) 0.31
(e) None of the above

*5. The angular position of a rotating object is caused to varies with time according to the equation, $\theta = 10 + 3t\ln(t)$, where θ is in radians, and t is in seconds. What will be the object's angular velocity when its angular location is $\theta = 40$ radians?

(a) 2.13
(b) 8.24
(c) 8.87
(d) 11.44
(e) None of the above

6. The torque acting on an object at rest at $\theta = 0$ varies with angular position according to the equation, $\tau(\theta) = 2\theta$, where τ is in m-N and θ is in radians. What will be the rotational kinetic energy of the object (in joules) after the object has been rotated through 120 radians?

(a) 6,400
(b) 9,600
(c) 14,400
(d) 36,800
(e) None of the above

*7. The rotational inertia of an object is 4 kg-m^2. At time t = 0, the object is at rest. A machine provides a torque acting on the object that causes it to accelerate angularly according to the equation, $\alpha(t) = 2t\, e^{0.20t}$. What is the approximate power output (in watts) of the machine at t = 5 s?

(a) 5437
(b) 3212
(c) 968
(d) 1235
(e) None of the above

*8. A 5-kg hollow sphere ($I = 2MR^2/3$) rolls without slipping from rest down a ramp from a height of 6 meters. What the speed, v (in m/s), of the sphere's center at the bottom of the ramp?

(a) 7.56
(b) 3.58
(c) 4.56
(d) 8.40
(e) None of the above

9. The rotational inertia of a collapsing spinning star drops to 1/3 of it initial value. What is the ratio of new rotational energy to its initial rotational energy?

(a) 3
(b) 1/9
(c) 1/3
(d) 1
(e) None of the above

10. A 50 N force is applied tangentially to the edge of a cylinder at rest, mounted on an axle passing lengthwise through the cylinder's center. Its radius is 0.30 m, and its rotational inertia is 30 kg-m^2. What will be the angular speed (in rad/s) five seconds later?

(a) 4.56
(b) 2.04
(c) 11.30
(d) 2.50
(e) None of the above

*11. The position of a particle of mass m = 2.0 kg is given at time t by the equation, $\mathbf{r} = 3t\,\mathbf{i} - t^2\,\mathbf{j} + 2\mathbf{k}$, where **r** is measured in meters from the origin, and t is in seconds. What is the angular momentum of the particle with respect to the origin at time t = 2 s?

(a) $12\mathbf{i} - 8\,\mathbf{j} + 8\,\mathbf{k}$
(b) $16\mathbf{i} + 12\,\mathbf{j} - 24\,\mathbf{k}$
(c) $12\mathbf{i} + 8\,\mathbf{j} + 8\,\mathbf{k}$
(d) 0
(e) None of the above

*12. A circular horizontal platform of radius 2.6 m has a rotational inertia of 630 kg-m^2, and is rotating at 3.0 rad/s. A 40-kg child running along a line that is tangent to the platform jumps onto the edge of the platform, which is moving in the same direction as the child. If the angular speed afterward is 2.70 rad/s, what was the speed (in m/s) of the child before jumping on the platform? (Treat the child as a "point" mass.)

(a) 2.45
(b) 4.34
(c) 5.20
(d) 6.08
(e) None of the above

13. A 5 meter, 800 N, uniform pole is hinged to a wall. Attached to the other end is a cable that is tied to the wall, and a rope, at the end of which is hanging a 1000 N weight. Other distances are indicated in the figure. What is the tension in the cable, in newtons?

(a) 1867
(b) 1959
(c) 3412
(d) 2854
(e) None of the above

14. Equal but opposite tensile forces of 10,000 N are applied to the ends of a 400-meter long steel cylindrical wire of radius 0.008 m. By how many meters is the wire elongated? Young's modulus for steel is 2.0×10^{11} N/m^2.

(a) 0.10
(b) 0.23
(c) 0.34
(d) 0.56
(e) None of the above

15. A rope of negligible mass is stretched horizontally between two supports that are 3.44 m apart. When an object of weight 3160 N is hung at the center of the rope, the rope is observed sag by 0.35 m. What is the tension in the rope, in newtons?

(a) 7920
(b) 2460
(c) 1350
(d) 1890
(e) None of the above

16. What must be the separation (in m) between the centers of two uniform spheres, each of mass 500 kg, for the mutual gravitational force between them to be 4.0×10^{-6} N? $G = 6.67 \times 10^{-11}$ N-m^2/kg^2.

(a) 5.87
(b) 2.04
(c) 3.56
(d) 6.78
(e) None of the above

17. The mass of Earth is M, and its radius is R. If an object of mass m that's at rest at a distance 3R from the center of Earth is dropped, what will be its kinetic energy when it strikes the ground?

(a) GMm/2R
(b) GMm/R
(c) 2GMm/R
(d) 2GMm/3R
(e) None of the above

18. The gravitational force between two objects separated by a certain distance is 1000 N. What will be the new gravitational force in newtons between the two objects if the mass of one of the objects is halved, the mass of the other is quadrupled, and the separation between the centers of the objects is reduced to one-third of the previous distance?

(a) 4,000
(b) 24,000
(c) 36,000
(d) 18,000
(e) None of the above

19. Two point-sized objects of mass 3 kg and 5 kg respectively, are 10 meters apart. How far (in meters) from the 3 kg mass may a third point-sized mass be placed in order to experience zero net gravitational force?

(a) 3.98
(b) 4.11
(c) 4.36
(d) 4.57
(e) None of the above

20. A uniform 3-m long board weighing 600 N is supported by the shoulders of two persons. The first person is located 0.3 m from the left end, while the second is 0.8 meters from the right end. What force (in N) is exerted on the board by the second person?

(a) 341
(b) 356
(c) 362
(d) 369
(e) None of the above