Physics 53 Final Exam Dr. Alward Spring 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. After how many seconds will the disc have rotated through 600 radians?

(a) 8.76
(b) 5.60
(c) 6.54
(d) 9.44
(e) None of the above

2. The angular acceleration of a wheel is 4 rad/s^2. Through how many radians will the wheel rotate during the period of time in which its angular speed changed from 80 rad/s to 120 rad/s?

(a) 1000
(b) 1600
(c) 1800
(d) 2000
(e) None of the above

*3. The angular position of a rotating object is caused to vary with time according to the equation, $\theta = 10 + 3t^2\ln(t)$, where θ is in radians, and t is in seconds. What will be the object's angular velocity (in rad/s) when its angular location is $\theta = 40$ radians?

(a) 22.31
(b) 28.93
(c) 31.45
(d) 44.56
(e) None of the above

*4. 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, $\alpha(t) = 2t^2$. About how much work (in joules) will the machine have done on the object between times t = 2.0 s and t = 3.0 s?

(a) 591
(b) 3212
(c) 968
(d) 1240
(e) None of the above

5. 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 kinetic energy (in joules) of the particle at time t = 2 s?

(a) 25.00
(b) 43.60
(c) 56.78
(d) 64.50
(e) None of the above

*6. A 800 N, uniform pole, 5 m long, 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 force (in newtons) on the pole exerted by the hinge?

(a) 2947
(b) 4132
(c) 3789
(d) 6412
(e) None of the above

*7. The mass of Earth is M, and its radius is R. If an object of mass m is moving at speed v at a distance 3R from the center of Earth, how far from the center of Earth will it be when it reaches its maximum height?

(a) $[(6GM - v_0^2R) / (3GMR)]^{1/2}$
(b) $[(GM - v_0^2R) / (2GMR)]^{1/2}$
(c) $[(6GMR/(2GM - 3v_0^2R))]^{1/2}$
(d) $[(GM - 3v_0^2R) / (2GMR)]^{1/2}$
(e) None of the above

8. A 3.6-kg ball swinging at constant angular speed in a vertical circular path at the end of a string of radius 1.2 m is at the top of its swing. The tension in the string is 101 N. About how many revolutions per minute are being completed?

(a) 35
(b) 54
(c) 87
(d) 103
(e) None of these

9. Three forces in a plane act on a 4-kg mass. The magnitudes (in newtons) and directions in degrees measured with respect to the positive x-axis, rotated counter-clockwise, are **A** = <100, 40º>, **B** = <140, 120º>, and **C** = <80, 230º>. What is the acceleration of the mass, in m/s^2?

(a) 33.02
(b) 11.56
(c) 34.90
(d) 27.32
(e) None of these

10. What force in newtons is required by the pulling force P in order to lift the 3100 N weight?

(a) 587.5
(b) 784.3
(c) 912.2
(d) 414.5
(e) None of these

11. A net horizontal force acting on an object varies with position according to the equation $F(x) = 4000x + 2xe^{2x}$, where F is in newtons, and x is in meters. What will be the change in the object's kinetic energy (in joules) as the object moves from x = 0 m to x = 3 m?

(a) 8,124
(b) 9,285
(c) 19,009
(d) 22,212
(e) None of these

12. The position of a 100-kg object to vary with time according to the equation $x(t) = 3t^2/(t + 3)$, where x is in meters, and t is in seconds. What is the kinetic energy (in joules) of the object when t = 2.0 s?

(a) 184
(b) 305
(c) 856
(d) 2341
(e) None of these

13. A 10-kg block is pulled up an inclined plane by a rope exerting a 200 N force parallel to the incline. The angle between the incline and the horizontal is 60º. The coefficient of friction between the block and the plane is 0.20. What is the magnitude of the work (in joules) that will have been done *by friction* on the block after it has been moved 4 meters up the plane?

(a) 196
(b) 543
(c) 403
(d) 236
(e) None of these

14. A conservative net force acting on an object is given by the equation, $F(x) = -2x^2 + 4$, where F is in joules, and x is in meters. What change in potential energy (in joules) would be experienced by the object as it moves from x = 1 m to x = 2 m?

(a) 1.24
(b) 4.56
(c) 0.67
(d) 2.31
(e) None of these

*15. A 4-meter long, uniform 500 N ladder leans against a frictionless wall, making an angle of 60º with respect to the ground. If the ladder is not slipping, what must be the static frictional force (in newtons) acting on the base of the ladder?

(a) 216.51
(b) 276.32
(c) 287.90
(d) 312.09
(e) None of these

*16. A rod of length 2.4 meters is of non-uniform density, having a linear density in kg/m given by the equation, $\lambda(x) = 50 + (8/x)\ln(x+1)$, where λ is in kg/m, and x is in meters, where x is measured from the left end of the rod, where the density is least. What is the approximate x-coordinate of the center of mass of the rod, in meters?

(a) 1.6
(b) 1.7
(c) 1.8
(d) 1.9
(e) None of these

*17. A pitched ball having a mass of 200 grams (0.200 kg), moving at 55 m/s, is struck by a bat that is in contact with the ball for 0.01 second. After leaving the bat, the ball travels at an angle of 40º with respect to the ground. It rises to its maximum height in 3.0 seconds. What was the approximate average force (in newtons) exerted by the bat on the ball?

(a) 1400
(b) 2000
(c) 2200
(d) 8000
(e) None of these

18. An automobile's speed is increased uniformly from 20 m/s to 56 m/s during a four-second time period. How much farther (in meters) will it travel during the next three seconds?

(a) 254.50
(b) 312.80.
(c) 213.40
(d) 178.64
(e) None of the above

19. An object moving at 10 m/s at t = 0 begins accelerating according to the equation, $a = 2 + 4t$, where a is in m/s^2, and t is in seconds. How far (in meters) will this object travel during a time period that begins at t = 2s and ends at t = 4 s?

(a) 69.33
(b) 102.91
(c) 85.26
(d) 41.45
(e) None of the above

20. An arrow is fired upward at an initial speed of 60 m/s. What is the height of the arrow one second after it reaches its maximum height?

(a) 49.23
(b) 163.27
(c) 78.42
(d) 103.98
(e) None of the above

21. An object's position is given by the equation, $x = 40 + 30t - 2t^2$, where x is in meters, and t is in seconds. At t = 0, the object is moving to the right at 30 m/s. What will be the x-coordinate (in meters) of the object when it reverses direction?

(a) 68.50
(b) 152.50
(c) 240.95
(d) 396.30
(e) None of the above

22. The x, y, and z components of a vector **A** are <3, 2, 1>, and the components of a vector **B** are <2, -2, 4>. What is the angle (in degrees) between these two vectors?

(a) 112.62
(b) 99.03
(c) 104.86
(d) 109.11
(e) None of the above

*23. An airplane's heading is 60º. Its air speed is 200 miles per hour. The air is moving at 40 miles per hours with respect to the ground along a heading of 100º. What is the airplane's speed with respect to the ground?

(a) 216
(b) 220
(c) 227
(d) 232
(e) None of the above

*24. An artillery cannon is 300 meters away from the side of a tall cliff. Projectiles fired from the cannon have a speed of 100 m/s. At what angle above the horizontal, in degrees, should a projectile be fired in order to strike a point on the cliff 70 meters up the side of the cliff?

(a) 22.02
(b) 23.13
(c) 34.56
(d) 48.45
(e) None of these

25. A 40-kg object moving to the right at 20 m/s collides with a 30-kg moving to the right at 16 m/s. The objects stick together. How much kinetic energy was "lost" during this collision, in joules?

(a) 43
(b) 98
(c) 110
(d) 137
(e) None of these

26. The speed of water flowing at the left end of a horizontal pipe is 1.4 m/s, and the fluid pressure at that end is 9000 Pa. The pipe narrows at the right end, where the pressure is 8000 Pa. What is the speed (in m/s) of the water at the right end?

(a) 1.65
(b) 1.78
(c) 1.99
(d) 2.31
(e) None of the above

*27. A solid block of wood in the shape of a cube 40-cm on each side has a density of 700 kg/m^3. The block is floating in water. What is the least downward push (in newtons) on the top of the block that will cause all of the block to be under water?

(a) 126
(b) 188
(c) 202
(d) 308
(e) None of the above

*28. An object of mass m = 1.5 kg is oscillating at the end of a spring whose spring constant is 216 N/m. Its equation of motion has the form, $x = A\cos(\omega t + \varphi)$. At time t = 3.0 seconds, the object is at x = 4.0 cm. When t = 5.0 seconds, the object is at x = 7.0 cm. What is the phase constant, φ, in radians?

(a) 5.81
(b) 6.78
(c) 11.22
(d) 23.67
(e) None of the above

29. Two speakers broadcasting 100 Hz sound are five meters apart. A listener located midway between the two speakers hears a maximum. How far (in meters) to the right (or to the left) must the listener move in order to hear a minimum?

(a) 0.86
(b) 1.12
(c) 1.26
(d) 2.34
(e) None of the above

30. A 0.25 kg block oscillates horizontally at the end of a spring whose spring constant is 500 N/m. If the oscillation is started by elongating the spring 0.15 m and while the block is held at that position, striking it to give it a speed of 3.0 m/s, then the maximum speed (in m/s) of the block is:

(a) 1.13
(b) 2.18
(c) 3.73
(d) 7.35
(e) None of the above

31. The speed of waves on a string of length L = 1.20 m under tension is 100 m/s. What must be the frequency (in hertz, Hz) at which one end of the string is vibrated in order to cause a standing wave with two anti-nodes?

(a) 312
(b) 208
(c) 246
(d) 346
(e) None of the above

32. The sound intensity at a particular point is 3.0×10^{-4} W/m^2. If the "decibel level" at that point is decreased by 6 dB, what would be the approximate new sound intensity at that point, in W/m^2?

(a) 9.4×10^{-4}
(b) 7.5×10^{-5}
(c) 5.9×10^{-5}
(d) 4.8×10^{-5}
(e) None of the above

33. What is the approximate difference in frequency (in hertz) between any two consecutive harmonics (frequencies) in an open-open tube of length L = 1.20 m?

(a) 143
(b) 72
(c) 286
(d) 358
(e) None of the above