Chapter 11 – Problem Day

29. At one instant, force $\vec{F} = (4\,N)\hat{j}$ acts on a 0.25 kg object that has position vector $\vec{r} = (2m)\hat{i} + (-2m)\hat{k}$ and velocity vector $\vec{v} = (-5\,m/s)\hat{i} + (5\,m/s)\hat{k}$. About the origin and in unit vector notation, what are (a) the object's angular momentum and (b) the torque acting on the object?

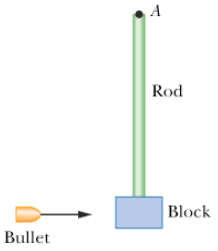
30. At the instant the displacement of a 2.00 kg object relative to the origin is $\vec{d} = (2\,m)\hat{i} + (4\,m)\hat{j} - (3\,m)\hat{k}$, its velocity is $\vec{v} = (-6\,m/s)\hat{i} + (3\,m/s)\hat{j} + (3\,m/s)\hat{k}$ and it is subject to a force $\vec{F} = (6\,N)\hat{i} - (8\,N)\hat{j} + (4\,N)\hat{k}$. Find (a) the acceleration of the object, (b) the angular momentum of the object about the origin, (c) the torque about the origin acting on the object, and (d) the angle between the velocity of the object and the force acting on the object.

33. A 3.0 kg particle with velocity $\vec{v} = (5\,m/s)\hat{i} - (6\,m/s)\hat{j}$ is at $x = 3.0$ m, $y = 8.0$ m. It is pulled by a 7.0 N force in the negative x direction. About the origin, what are (a) the particle's angular momentum, (b) the torque acting on the particle, and (c) the rate at which the angular momentum is changing?

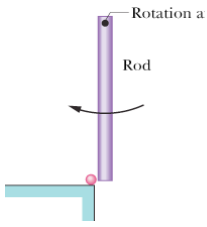
36. A sanding disk with rotational inertia 1.2×10^{-3} kg·m^2 is attached to an electric drill whose motor delivers a torque of magnitude 16 N·m about the central axis of the disk. About that axis and with the torque applied for 33 ms, what is the magnitude of the (a) angular momentum and (b) angular velocity of the disk?

45. A wheel is rotating freely at angular speed 800 rev/min on a shaft whose rotational inertia is negligible. A second wheel, initially at rest and with twice the rotational inertia of the first, is suddenly coupled to the same shaft. (a) What is the angular speed of the resultant combination of the shaft and two wheels? (b) What fraction of the original rotational kinetic energy is lost?

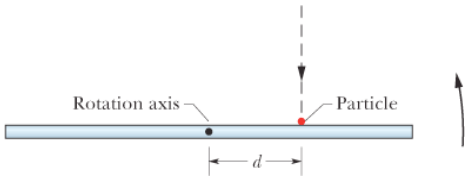
58. In the figure, a 1.0 g bullet is fired into a 0.50 kg block attached to the end of a 0.60 m non-uniform rod of mass 0.50 kg. The block–rod–bullet system then rotates in the plane of the figure, about a fixed axis at A. The rotational inertia of the rod alone about that axis at A is 0.060 kg·m^2. Treat the block as a particle. (a) What then is the rotational inertia of the block–rod–bullet system about point A? (b) If the angular speed of the system about A just after impact is 4.5 rad/s, what is the bullet's speed just before impact?



61. The uniform rod (length 0.60 m, mass 1.0 kg) in the figure rotates in the plane of the figure about an axis through one end, with a rotational inertia of 0.12 kg·m^2. As the rod swings through its lowest position, it collides with a 0.20 kg putty wad that sticks to the end of the rod. If the rod's angular speed just before collision is 2.4 rad/s, what is the angular speed of the rod–putty system immediately after collision?



63. The figure is an overhead view of a thin uniform rod of length 0.600 m and mass M rotating horizontally at 80.0 rad/s counterclockwise about an axis through its center. A particle of mass $M/3.00$ and traveling horizontally at speed 40.0 m/s hits the rod and sticks. The particle's path is perpendicular to the rod at the instant of the hit, at a distance d from the rod's center. (a) At what value of d are rod and particle stationary after the hit? (b) In which direction do rod and particle rotate if d is greater than this value?



Chapter 11 Answers

29a) 0

29b) $(8N \cdot m)\hat{i} + (8N \cdot m)\hat{k}$

30a) $(3\,{}^{m}/_{s^2})\hat{i} - (4\,{}^{m}/_{s^2})\hat{j} + (2\,{}^{m}/_{s^2})\hat{k}$

30b) $(42\,{}^{m^2}/_{s})\hat{i} + (24\,{}^{m^2}/_{s})\hat{j} + (60\,{}^{m^2}/_{s})\hat{k}$

30c) $-(8N \cdot m)\hat{i} - (26N \cdot m)\hat{j} - (40N \cdot m)\hat{k}$

30d) 127°

33a) $(-174\,{}^{kg \cdot m^2}/_{s})\hat{k}$

33b) $(56N \cdot m)\hat{k}$

33c) 56 N·m

36a) 0.528 N·m

36b) 440 rad/s

45a) 267 rev/min = 27.93 rad/s

45b) 2/3

58a) 0.24036 kg·m^2

58b) 1803 m/s

61) 1.5 rad/s

63a) 0.180 m