Angular Energy and Momentum problems from 8.3

A Basic Energy:

1. What is the kinetic energy of a flywheel with a moment of inertia of 12.4 kgm^2 that is spinning at 17.8 rad/s? (1960 J)
2. A flywheel spins at 87.0 rot/s when it is storing 12,500 J of kinetic energy. What is its moment of inertia? (0.0837 kgm^2)
3. What is the speed in RPMs of a 4.50 kg 34.0 cm diameter cylindrical grinding disk if it has 340. J of rotational kinetic energy? (977 RPM)
4. A 4.50 kg 12.0 cm radius bowling ball is rolling at 3.20 m/s. What is its translational kinetic energy? What is its rotational kinetic energy? What is its total kinetic energy? If it rolled from rest down a hill, how high is the hill? (23.0 J, 9.22 J, 32.3 J 0.731 m)
5. If linear work is given by $W = Fs$, then angular work is $W = I\theta$. Use energy to find the angular final velocity of a flywheel that has a moment of inertia of 8.50 kgm^2 after it has been sped from rest up by a torque of 52.0 mN through 84.0 radians. (32.1 Rad/s)

B Rolling problems:

For all of these:

a. Set up the appropriate dynamics or conservation of energy equation, substitute for ω or α, and for I, and solve for v or a. Show your steps Give an exact answer. (you will need to give an answer with a simplified fraction!)
b. Solve for the final velocity of the marble at the bottom of the incline.
c. Calculate the acceleration of the marble as it rolls down the incline.

1. A 11.0 g, 0.0110 m radius unique circular solid with a moment of inertia given by $^2/_5mr^2$, rolls down an incline that is 2.60 m long, and loses 0.560 m of elevation. (2.80 m/s, 1.51 m/s/s)
2. A 13.0 g, 0.0130 m radius unique circular solid with a moment of inertia given by $^1/_2mr^2$, rolls down an incline that is 5.10 m long, and loses 1.90 m of elevation. (4.99 m/s, 2.44 m/s/s)
3. A 15.0 g, 0.0140 m radius unique circular solid with a moment of inertia given by $^1/_3mr^2$, rolls down an incline that is 4.10 m long, and loses 1.30 m of elevation. (4.37 m/s, 2.33 m/s/s)
4. A 143.0 g, 0.0450 m radius unique circular solid with a moment of inertia given by $^2/_7mr^2$, rolls down an incline that is 3.30 m long, and loses 1.10 m of elevation. (4.10 m/s, 2.54 m/s/s)
5. A 12.0 g, 0.0120 m radius unique circular solid with a moment of inertia given by $^7/_8mr^2$, rolls down an incline that is 3.20 m long, and loses 0.340 m of elevation. (1.89 m/s, 0.556 m/s/s)

C Basic Momentum:

1. What is the angular momentum of a disk with a moment of inertia of 0.145 kgm^2 that is spinning at 45.0 rad/s? (6.53 kgm^2/s)
2. What angular velocity in rad/s must a 120. kg 1.80 m radius cylindrical merry go round go to have 2360 kg m^2/s of angular momentum? (12.1 rad/s)
3. What torque would speed up a merry go round with 296 kgm^2 of rotational inertia from rest to 6.28 rad/s in 32.0 seconds? (58.1 mN)
4. A 2.60 kg cylindrical flywheel with a diameter of 54.0 cm is spinning at 115 rad/s. If a frictional torque of 1.30 mN acts on it, in what time would it stop? (8.38 s)
5. A ballerina spinning at 1.20 rev/sec with a moment of inertia of 2.60 Kg m^2 pulls her arms in so that her new moment of inertia is 1.80 Kg m^2. What is her new angular speed? (1.73 rev/sec)
6. A group of children playing on a merry go round spinning at 52.0 rpm with a moment of inertia of 200. Kg m^2 move to its center so that the new angular velocity is 86.7 RPM. What is the new moment of inertia? (120. kgm^2)

D Momentum Questions:

1. A 54.0 kg child is 1.80 m from the center of a 2.10 m radius merry go round that is a 170. kg cylinder.
a. If a torque of 92.0 mN is applied for 13.0 seconds, what is the change in angular velocity? b. The child moves out to a distance of 2.10 m, and as a result the merry go round is spinning at 0.450 rot/s. What was its initial angular velocity in rot/s? (2.18 rad/s, 0.502 rot/s)

2. A 68.0 kg child is 2.70 m from the center of a 3.30 m radius merry go round that is a 140. kg cylinder.
a. For what time must a torque of 31.0 mN act to accelerate the merry go round from rest to 5.20 rad/s? b. When the merry go round is spinning at 21.0 RPM, the child moves in to a distance of 1.90 m from the center. What is the final angular velocity in RPM? (211 s, 26.2 RPM)

3. A 51.0 kg child is 1.10 m from the center of a 2.40 m radius merry go round that is a 160. kg cylinder.
a. If the merry go round speeds up from rest to 4.70 rad/s in 14.0 seconds, what torque was acting? b. When the merry go round is rotating at 0.970 rot/s, the child moves out to a distance of 2.30 m from the center. What is the new angular velocity of the merry go round in rot/s? (175 mN, 0.694 rot/s)

4. A 41.0 kg child is 2.20 m from the center of a 2.40 m radius merry go round that is a 150. kg cylinder.
a. If a torque of 95.0 mN acts on the merry go round for 8.00 seconds, what is the change in angular velocity? b. The child moves in to a distance of 1.10 m from the center, and as a result, the angular velocity of the merry go round is 65.0 RPM. What was the initial angular velocity in RPM? (1.21 rad/s, 49.7 RPM)

5. A 58.0 kg child is 1.00 m from the center of a 2.20 m radius merry go round that is a 180. kg cylinder.
a. For what time must a torque of 35.0 mN act on the merry go round to change its angular velocity from rest to 3.50 rad/s? b. If the merry go round is spinning at 0.780 rot/s, and the child moves out to 2.20 m from the center, what is the final angular velocity in rot/s? (49.4 s, 0.537 rot/s)

So you think you're so dang smart?

Giancoli #67: Suppose a 55-kg person stands at the edge of a 6.5-m diameter merry-go-round turntable that is mounted on frictionless bearings and has a moment of inertia of 1700 kgm^2. The turntable is at rest initially, but when the person begins running at a speed of 3.8 m/s (with respect to the turntable) around its edge, the turntable begins to rotate in the opposite direction. Calculate the angular velocity of the turntable.
(-0.30 rad/s)