

CHAPTER 8

3. If a net torque is applied to an object, that object will experience:
 - a. a constant angular speed
 - b. an angular acceleration
 - c. a constant moment of inertia
 - d. an increasing moment of inertia
4. According to Newton's second law, the angular acceleration experienced by an object is directly proportional to:
 - a. its moment of inertia
 - b. the net applied torque
 - c. the object's size
 - d. choices a and b above are both valid
6. A ventilation fan with a moment of inertia of $0.034 \text{ kg}\cdot\text{m}^2$ has a net torque of $0.11 \text{ N}\cdot\text{m}$ applied to it. If it starts from rest, what angular momentum will it have 8.0 s later?
 - a. $0.88 \text{ kg}\cdot\text{m}^2/\text{s}$
 - b. $0.97 \text{ kg}\cdot\text{m}^2/\text{s}$
 - c. $2.0 \text{ kg}\cdot\text{m}^2/\text{s}$
 - d. $3.25 \text{ kg}\cdot\text{m}^2/\text{s}$
7. A ventilation fan with a moment of inertia of $0.034 \text{ kg}\cdot\text{m}^2$ has a net torque of $0.11 \text{ N}\cdot\text{m}$ applied to it. If it starts from rest, what kinetic energy will it have 8.0 s later?
 - a. 31 J
 - b. 17 J
 - c. 11 J
 - d. 6.6 J
8. A disk has a moment of inertia of $3.0 \times 10^{-4} \text{ kg}\cdot\text{m}^2$ and rotates with an angular speed of 3.5 rad/sec . What net torque must be applied to bring it to rest within 3 s ?
 - a. $4.5 \times 10^{-3} \text{ N}\cdot\text{m}$
 - b. $7.5 \times 10^{-4} \text{ N}\cdot\text{m}$
 - c. $3.5 \times 10^{-4} \text{ N}\cdot\text{m}$
 - d. $5.0 \times 10^{-4} \text{ N}\cdot\text{m}$

9. A figure skater with arms initially extended starts spinning on the ice at 3 rad/s. She then pulls her arms in close to her body. Which of the following results?
- a. a smaller rotational rate
 - b. a greater rotational rate
 - c. a greater angular momentum
 - d. a smaller angular momentum
10. The total kinetic energy of a baseball thrown with a spinning motion is a function of:
- a. its linear speed but not rotational speed
 - b. its rotational speed but not linear speed
 - c. both linear and rotational speeds
 - d. neither linear nor rotational speed
11. The Earth moves about the Sun in an elliptical orbit. As the Earth moves closer to the Sun, which of the following best describes the Earth-Sun system's moment of inertia?
- a. decreases
 - b. increases
 - c. remains constant
 - d. none of the above choices are valid
12. A bowling ball has a mass of 7.0 kg, a moment of inertia of $2.8 \times 10^{-2} \text{ kg}\cdot\text{m}^2$ and a radius of 0.10 m. If it rolls down the lane without slipping at a linear speed of 4.0 m/s, what is its angular speed?
- a. 0.80 rad/s
 - b. 10 rad/s
 - c. 0.050 rad/s
 - d. 40 rad/s
13. A bowling ball has a mass of 7.0 kg, a moment of inertia of $2.8 \times 10^{-2} \text{ kg}\cdot\text{m}^2$ and a radius of 0.10 m. If it rolls down the lane without slipping at a linear speed of 4.0 m/s, what is its total kinetic energy?
- a. 45 J
 - b. 32 J
 - c. 11 J
 - d. 78 J

15. A baseball pitcher loosens up his pitching arm. He tosses a 0.15-kg ball using only the rotation of his forearm, 0.32 m in length, to accelerate the ball. What is the moment of inertia of the ball alone as it moves in a circular arc with a radius of 0.32 m?
- a. $1.5 \times 10^{-2} \text{ kg}\cdot\text{m}^2$
 - b. $16 \times 10^{-2} \text{ kg}\cdot\text{m}^2$
 - c. $4.0 \times 10^{-2} \text{ kg}\cdot\text{m}^2$
 - d. $7.6 \times 10^{-2} \text{ kg}\cdot\text{m}^2$
16. A baseball pitcher loosens up his pitching arm. He tosses a 0.15-kg ball using only the rotation of his forearm, 0.32 m in length, to accelerate the ball. If the ball starts at rest and is released with a speed of 12 m/s in a time of 0.40 s, what torque is applied to the ball while being held by the pitcher's hand to produce the angular acceleration?
- a. 1.1 N·m
 - b. 11 N·m
 - c. 7.2 N·m
 - d. 1.4 N·m
18. A bucket of water with total mass 23 kg is attached to a rope, which in turn is wound around a 0.050-m radius cylinder at the top of a well. A crank with a turning radius of 0.25 m is attached to the end of the cylinder. What minimum force directed perpendicular to the crank handle is required to raise the bucket? (Assume the rope's mass is negligible, that cylinder turns on frictionless bearings, and that $g = 9.8 \text{ m/s}^2$.)
- a. 45 N
 - b. 68 N
 - c. 90 N
 - d. 135 N
19. A bucket of water with total mass 23 kg is attached to a rope, which in turn is wound around a 0.050-m radius cylinder at the top of a well. A crank with a turning radius of 0.25 m is attached to the end of the cylinder and the moment of inertia of cylinder and crank is $0.12 \text{ kg}\cdot\text{m}^2$. If the bucket is raised to the top of the well and released, what is the acceleration of the bucket as it falls toward the bottom of the well? (Assume rope's mass is negligible, that cylinder turns on frictionless bearings and that $g = 9.8 \text{ m/s}^2$.)
- a. 3.2 m/s^2
 - b. 6.3 m/s^2
 - c. 7.4 m/s^2
 - d. 9.8 m/s^2
20. A bucket of water with total mass 23 kg is attached to a rope, which in turn is wound around a 0.050-m radius cylinder at the top of a well. The bucket is raised to the top of the well and released. The bucket is moving with a speed of 8.0 m/s upon hitting the water surface in the well. What is the angular speed of the cylinder at this instant?
- a. 39 rad/s
 - b. 79 rad/s

- c. 120 rad/s
- d. 160 rad/s

21. A bucket of water with total mass 23 kg is attached to a rope, which in turn is wound around a 0.050-m radius cylinder, with crank, at the top of a well. The moment of inertia of the cylinder and crank is $0.12 \text{ kg}\cdot\text{m}^2$. The bucket is raised to the top of the well and released to fall back into the well. What is the kinetic energy of the cylinder and crank at the instant the bucket is moving with a speed of 8.0 m/s?
- a. $2.1 \times 10^3 \text{ J}$
 - b. $1.5 \times 10^3 \text{ J}$
 - c. $0.70 \times 10^3 \text{ J}$
 - d. $0.40 \times 10^3 \text{ J}$
22. A solid sphere of mass 4.0 kg and radius 0.12 m is at rest at the top of a ramp inclined 15° . It rolls to the bottom without slipping. The upper end of the ramp is 1.2 m higher than the lower end. Find the sphere's total kinetic energy when it reaches the bottom.
- a. 70 J
 - b. 47 J
 - c. 18 J
 - d. 8.8 J
23. A solid sphere of mass 4.0 kg and radius 0.12 m starts from rest at the top of a ramp inclined 15° , and rolls to the bottom. The upper end of the ramp is 1.2 m higher than the lower end. What is the linear speed of the sphere when it reaches the bottom of the ramp? (Note: $I = 0.4MR^2$ for a solid sphere and $g = 9.8 \text{ m/s}^2$)
- a. 4.7 m/s
 - b. 4.1 m/s
 - c. 3.4 m/s
 - d. 2.4 m/s
24. A solid cylinder of mass 3.0 kg and radius 0.2 m starts from rest at the top of a ramp, inclined 15° , and rolls to the bottom without slipping. (For a cylinder $I = 0.5MR^2$) The upper end of the ramp is 1.2 m higher than the lower end. Find the linear speed of the cylinder when it reaches the bottom of the ramp. ($g = 9.8 \text{ m/s}^2$)
- a. 4.7 m/s
 - b. 4.3 m/s
 - c. 4.0 m/s
 - d. 2.4 m/s
27. An ice skater spins at 2.5 rev/s when his arms are extended. He draws his arms in and spins at 6.0 rev/s. By what factor does his moment of inertia change in the process?
- a. 2.4
 - b. 1.0
 - c. 0.42
 - d. 0.12

28. A figure skater on ice with arms extended, spins at a rate of 2.5 rev/s. After he draws his arms in, he spins at 6.0 rev/s. By what factor does the skater's kinetic energy change when he draws his arms in?
- 2.4
 - 1.0
 - 0.42
 - 0.12
32. A cylinder with its mass concentrated toward the center has a moment of inertia of $0.1 MR^2$. If this cylinder is rolling without slipping along a level surface with a linear speed v , what is the ratio of its rotational kinetic energy to its linear kinetic energy?
- 1/10
 - 1/5
 - 1/2
 - 1/1
33. A solid sphere with mass, M , and radius, R , rolls along a level surface without slipping with a linear speed, v . What is the ratio of rotational to linear kinetic energy? (For a solid sphere, $I = 0.4 MR^2$).
- 1/4
 - 1/2
 - 1/1
 - 2/5
34. A rotating flywheel can be used as a method to store energy. If it is required that such a device be able to store up to a maximum of 1.00×10^6 J when rotating at 400 rad/s, what moment of inertia is required?
- $50 \text{ kg}\cdot\text{m}^2$
 - $25 \text{ kg}\cdot\text{m}^2$
 - $12.5 \text{ kg}\cdot\text{m}^2$
 - $6.3 \text{ kg}\cdot\text{m}^2$
35. A rotating flywheel can be used as a method to store energy. If it has 1.0×10^6 J of kinetic energy when rotating at 400 rad/s, and if a frictional torque of 4.0 N·m acts on the system, in what interval of time would the flywheel come to rest?
- 3.5 min
 - 7.0 min
 - 14 min
 - 21 min

39. A cylinder ($I = MR^2/2$) is rolling along the ground at 7.0 m/s. It comes to a hill and starts going up. Assuming no losses to friction, how high does it get before it stops?
- a. 1.2 m
 - b. 3.7 m
 - c. 4.2 m
 - d. 5.9 m
40. A solid cylinder ($I = MR^2/2$) has a string wrapped around it many times. When I release the cylinder, holding on to the string, the cylinder falls and spins as the string unwinds. What is the downward acceleration of the cylinder as it falls?
- a. 0
 - b. 4.9 m/s^2
 - c. 6.5 m/s^2
 - d. 9.8 m/s^2
41. The Earth's gravity exerts no torque on a satellite orbiting the Earth in an elliptical orbit. Compare the motion at the point nearest the Earth (perigee) to the motion at the point farthest from the Earth (apogee). At these two points:
- a. the tangential velocities are the same.
 - b. the angular velocities are the same.
 - c. the angular momentum is the same.
 - d. the kinetic energies are the same.
42. The Earth's gravity exerts no torque on a satellite orbiting the Earth in an elliptical orbit. Compare the motion at the point nearest the Earth (perigee) to the motion at the point farthest from the Earth (apogee). At the point closest to the Earth:
- a. the angular speed will be greatest although the linear speed will be the same.
 - b. the speed will be greatest although the angular speed will be the same.
 - c. the kinetic energy and angular momentum will both be greater.
 - d. none of the above.

48. An astronaut is on a 100-m lifeline outside a spaceship, circling the ship with an angular speed of 0.100 rad/s . How far inward can she be pulled before the centripetal acceleration reaches $5g = 49 \text{ m/s}^2$?
- a. 10.1 m
 - b. 50.0 m
 - c. 72.7 m
 - d. 89.9 m
49. A vault is opened by applying a force of 300 N perpendicular to the plane of the door, 0.80 m from the hinges. Find torque due to this force about an axis through the hinges.
- a. 120 N·m
 - b. 240 N·m
 - c. 300 N·m
 - d. 360 N·m
50. A uniform bridge span weighs $50.0 \times 10^3 \text{ N}$ and is 40.0 m long. An automobile weighing $15.0 \times 10^3 \text{ N}$ is parked with its center of gravity located 12.0 m from the right pier. What upward support force does the left pier provide?
- a. $29.5 \times 10^3 \text{ N}$
 - b. $35.5 \times 10^3 \text{ N}$
 - c. $65.0 \times 10^3 \text{ N}$
 - d. $32.5 \times 10^3 \text{ N}$
51. Tasha has mass 20 kg and wants to use a 4.0-m board of mass 10 kg as a seesaw. Her friends are busy, so Tasha seesaws by herself by putting the support at the center of gravity when she sits on one end of the board. How far is she from the support point?
- a. 2.0 m
 - b. 1.0 m
 - c. 0.67 m
 - d. 0.33 m
52. An 80-kg man is one fourth of the way up a 10-m ladder that is resting against a smooth, frictionless wall. If the ladder has a mass of 20 kg and it makes an angle of 60° with the ground, find the force of friction of the ground on the foot of the ladder.
- a. $7.8 \times 10^2 \text{ N}$
 - b. $2.0 \times 10^2 \text{ N}$
 - c. 50 N
 - d. $1.7 \times 10^2 \text{ N}$
53. A 100-N uniform ladder, 8.0 m long, rests against a smooth vertical wall. The coefficient of static friction between ladder and floor is 0.40. What minimum angle can the ladder make with the floor before it slips?

- a. 22°
 - b. 51°
 - c. 18°
 - d. 42°
54. A meter stick is supported by a knife edge at the 50-cm mark. Doug hangs masses of 0.40 and 0.60 kg from the 20-cm and 80-cm marks, respectively. Where should Doug hang a third mass of 0.30 kg to keep the stick balanced?
- a. 20 cm
 - b. 70 cm
 - c. 30 cm
 - d. 25 cm
55. An 800-N billboard worker stands on a 4.0-m scaffold supported by vertical ropes at each end. If the scaffold weighs 500 N and the worker stands 1.0 m from one end, what is the tension in the rope nearest the worker?
- a. 450 N
 - b. 500 N
 - c. 800 N
 - d. 850 N

56. An 800-N billboard worker stands on a 4.0-m scaffold weighing 500 N and supported by vertical ropes at each end. How far would the worker stand from one of the supporting ropes to produce a tension of 550 N in that rope?
- a. 1.4 m
 - b. 2.0 m
 - c. 2.5 m
 - d. 2.7 m
57. A woman who weighs 500 N stands on an 8.0-m-long board that weighs 100 N. The board is supported at each end. The support force at the right end is 3 times the support force at the left end. How far from the right end is the woman standing?
- a. 4.0 m
 - b. 2.0 m
 - c. 2.7 m
 - d. 1.6 m
61. An object of radius R and moment of inertia I rolls down an incline of height H after starting from rest. Its total kinetic energy at the bottom of the incline
- a. is gR/I .
 - b. is I/gH .
 - c. is $0.5 Ig/H$.
 - d. cannot be found from the given information alone.
62. A solid sphere rolls down an incline of height 3 m after starting from rest. In order to calculate its speed at the bottom of the incline, one needs to know
- a. the mass of the sphere.
 - b. the radius of the sphere.
 - c. the mass and the radius of the sphere.
 - d. no more than is given in the problem.
63. An object with mass m and moment of inertia I is spinning with an angular momentum L . Its kinetic energy is
- a. $0.5 I^2/L$.
 - b. $0.5 L^2/I$.
 - c. $0.5 L^2/m$.
 - d. $0.5 I^2/m$.

65. An object consists of a rod (of length 3.0 m and negligible moment of inertia) to which four small 2.0-kg masses are attached, one at each end and one at each point on the rod 1.0 m from each end. (The masses are one meter apart.) The moment of inertia of this object about an axis perpendicular to the rod and through one of the inner masses
- a. is $72 \text{ kg}\cdot\text{m}^2$.
 - b. is $12 \text{ kg}\cdot\text{m}^2$.
 - c. is $4 \text{ kg}\cdot\text{m}^2$.
 - d. cannot be uniquely determined until it is stated which inner mass the axis goes through.
66. A uniform 1.0-N meter stick is suspended horizontally by vertical strings attached at each end. A 2.0-N weight is suspended from the 10-cm position on the stick, another 2.0-N weight is suspended from the 50 cm position, and a 3.0-N weight is suspended from the 60 cm position. What is the tension in the string attached at the 100-cm end of the stick?
- a. 1.9 N
 - b. 3.0 N
 - c. 3.5 N
 - d. 4.0 N

CHAPTER 8 - ANSWERS

#	Ans	Difficulty	#	Ans	Difficulty
1.	C	1	35.	D	2
2.	B	1	36.	B	3
3.	B	1	37.	B	2
4.	B	1	38.	C	2
5.	C	1	39.	B	2
6.	A	1	40.	C	3
7.	C	2	41.	C	2
8.	C	2	42.	D	2
9.	B	1	43.	D	3
10.	C	1	44.	C	2
11.	A	1	45.	B	2
12.	D	2	46.	A	2
13.	D	2	47.	C	2
14.	B	2	48.	C	3
15.	A	2	49.	B	2
16.	D	2	50.	A	2
17.	C	2	51.	C	2
18.	A	3	52.	D	3
19.	A	3	53.	B	3
20.	D	3	54.	C	2
21.	B	3	55.	D	2
22.	B	2	56.	C	2
23.	B	3	57.	D	2
24.	C	3	58.	C	2
25.	D	2	59.	B	2
26.	B	2	60.	B	3
27.	C	1	61.	D	2
28.	A	2	62.	D	2
29.	B	2	63.	B	1
30.	B	2	64.	B	1
31.	A	3	65.	B	3
32.	A	2	66.	C	2
33.	D	2	67.	C	2
34.	C	2	68.	B	3