Exam

Name_____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Angular displacement is usually express in units of 1) _____
A) arcs. B) meters. C) revolutions. D) radians.
Answer: D

2) Angular velocity is expressed in units of 2) _____
A) meters per second. B) omegas per second.
C) radians per second. D) arcs per second.
Answer: C

3) Angular acceleration is expressed in units of 3) _____
A) arcs per second squared. B) meters per second squared.
C) alphas per second squared. D) radians per second squared.
Answer: D

4) A boy and a girl are riding on a merry-go-round which is turning at a constant rate. The boy is near the outer edge, and the girl is closer to the center. Who has the greater angular displacement? 4) _____
A) the girl
B) the boy
C) Both have the same non-zero angular displacement.
D) Both have zero angular displacement.
Answer: C

5) A boy and a girl are riding on a merry-go-round which is turning at a constant rate. The boy is near the outer edge, and the girl is closer to the center. Who has the greater angular speed? 5) _____
A) the girl
B) the boy
C) Both have the same non-zero angular velocity.
D) Both have zero angular velocity.
Answer: C

6) A boy and a girl are riding on a merry-go-round which is turning at a constant rate. The boy is near the outer edge, and the girl is closer to the center. Who has the greater linear speed? 6) _____
A) the girl
B) the boy
C) Both have the same non-zero translational velocity.
D) Both have zero translational velocity.
Answer: B

7) A boy and a girl are riding a merry-go-round which is turning at a constant rate. The boy is near the outer edge, while the girl is closer to the center. Who has the greater centripetal acceleration? 7) _____
A) the boy
B) the girl
C) Both have the same non-zero centripetal acceleration.
D) Both have zero centripetal acceleration.
Answer: A

8) A boy and a girl are riding a merry-go-round which is turning at a constant rate. The boy is near the outer edge, while the girl is closer to the center. Who has the greater tangential acceleration? 8) _____

A) the girl
B) the boy
C) Both have the same non-zero tangential acceleration.
D) Both have zero tangential acceleration.

Answer: D

9) Consider a rigid body that is rotating. Which of the following is an accurate statement? 9) _____

A) Its center of rotation is at rest, i.e., not moving.
B) Its center of rotation is its center of gravity.
C) All points on the body are moving with the same linear velocity.
D) All points on the body are moving with the same angular velocity.

Answer: D

10) Rolling without slipping depends on 10) _____

A) tension between the rolling object and the ground.
B) kinetic friction between the rolling object and the ground.
C) the force of gravity between the rolling object and the Earth.
D) static friction between the rolling object and the ground.

Answer: D

11) Two equal forces are applied to a door. The first force is applied at the midpoint of the door; the second force is applied at the doorknob. Both forces are applied perpendicular to the door. Which force exerts the greater torque? 11) _____

A) the second at the doorknob
B) both exert zero torques
C) both exert equal non-zero torques
D) the first at the midpoint

Answer: A

12) Two equal forces are applied to a door at the doorknob. The first force is applied perpendicular to the door; the second force is applied at 30° to the plane of the door. Which force exerts the greater torque? 12) _____

A) the first applied perpendicular to the door
B) the second applied at an angle
C) both exert zero torques
D) both exert equal non-zero torques

Answer: A

13) Two forces are applied to a doorknob, perpendicular to the door. The first force is twice as large as the second force. The ratio of the torque of the first to the torque of the second is 13) _____

A) 1/2. B) 4. C) 1/4. D) 2.

Answer: D

14) What is the quantity used to measure an object's resistance to changes in rotation? 14) _____

A) mass
B) angular velocity
C) torque
D) moment of inertia

Answer: D

15) Consider two uniform solid spheres where both have the same diameter, but one has twice the mass of the other. The ratio of the larger moment of inertia to that of the smaller moment of inertia is 15) _____

A) 2. B) 6. C) 10. D) 4. E) 8.

Answer: A

16) Two uniform solid spheres have the same mass, but one has twice the radius of the other. The ratio of the larger sphere's moment of inertia to that of the smaller sphere is 16) _____

A) 4/5. B) 4. C) 8/5. D) 2.

Answer: B

17) Consider two uniform solid spheres where one has twice the mass and twice the diameter of the other. The ratio of the larger moment of inertia to that of the smaller moment of inertia is 17) _____

A) 4. B) 6. C) 10. D) 8. E) 2.

Answer: D

18) A uniform solid sphere has mass M and radius R. If these are increased to 2M and 3R, what happens to the sphere's moment of inertia about a central axis? 18) _____

A) increases by a factor of 18
B) increases by a factor of 12
C) increases by a factor of 6
D) increases by a factor of 54

Answer: A

19) If a constant net torque is applied to an object, that object will 19) _____

A) having an increasing moment of inertia.
B) rotate with constant angular acceleration.
C) having a decreasing moment of inertia.
D) rotate with constant angular velocity.

Answer: B

20) The moment of inertia of a solid cylinder about its axis is given by $0.5\ MR^2$. If this cylinder rolls without slipping, the ratio of its rotational kinetic energy to its translational kinetic energy is 20) _____

A) 2:1. B) 1:2. C) 1:1. D) 1:3.

Answer: B

21) Consider a motorcycle of mass 150 kg, one wheel of which has a mass of 10 kg and a radius of 30 cm. What is the ratio of the rotational kinetic energy of the wheels to the total translational kinetic energy of the bike? Assume the wheels are uniform disks. 21) _____

A) 0.33:1 B) 0.067:1 C) 0.67:1 D) 0.033:1

Answer: B

22) Suppose a solid sphere of mass *M* and radius *R* rolls without slipping down an inclined plane starting from rest. The linear velocity of the sphere at the bottom of the incline depends on 22) _____

A) both the mass and the radius of the sphere.
B) the mass of the sphere.
C) the radius of the sphere.
D) neither the mass nor the radius of the sphere.

Answer: D

23) Suppose a solid sphere of mass *M* and radius *R* rolls without slipping down an inclined plane starting from rest. The angular velocity of the sphere at the bottom of the incline depends on 23) _____
A) neither the mass nor the radius of the sphere.
B) the radius of the sphere.
C) both the mass and the radius of the sphere.
D) the mass of the sphere.

Answer: B

24) "The total angular momentum of a system of particles changes when a net external force acts on the system." This statement is 24) _____
A) always true.
B) sometimes true. It depends on the force's point of application.
C) sometimes true. It depends on the force's magnitude.
D) never true.

Answer: B

25) In what circumstances can the angular velocity of system of particles change without any change in the system's angular momentum? 25) _____
A) This can happen if an external net torque is applied properly to the system.
B) This can happen if the only forces acting are internal to the system.
C) This can happen if a net external force acts on the system's center of mass.
D) This cannot happen under any circumstances.

Answer: B

26) The Earth orbits the Sun in an elliptical orbit. Ignore any friction which may be present. What happens over time to the Earth's angular momentum about the Sun? 26) _____
A) It increases during some parts of the orbit, and decreases during others.
B) It continually increases.
C) It remains constant.
D) It continually decreases.

Answer: C

27) The Earth moves about the Sun in an elliptical orbit. As the Earth moves close to the Sun, then which of the following best describes the orbiting speed of the Earth about the Sun? 27) _____
A) remains constant
B) increases
C) decreases
D) none of the above

Answer: B

28) An ice skater performs a pirouette (a fast spin) by pulling in his outstretched arms close to his body. What happens to his angular momentum about the axis of rotation? 28) _____
A) It decreases.
B) It does not change.
C) It increases.
D) It changes, but it is impossible to tell which way.

Answer: B

29) An ice skater performs a pirouette (a fast spin) by pulling in his outstretched arms close to his body. What happens to his rotational kinetic energy about the axis of rotation? 29) _____

A) It does not change.
B) It decreases.
C) It increases.
D) It changes, but it is impossible to tell which way.

Answer: C

30) An ice skater performs a pirouette (a fast spin) by pulling in his outstretched arms close to his body. What happens to his moment of inertia about the axis of rotation? 30) _____

A) It decreases.
B) It increases.
C) It does not change.
D) It changes, but it is impossible to tell which way.

Answer: A

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

31) State the law of conservation of angular momentum.

Answer: The total angular momentum of a rotating object remains constant if the net torque acting on it is zero.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

32) What arc length does the Earth travel in a three month period in its nearly circular orbit about the Sun with a radius of 1.5×10^{11} m? 32) _____

A) 1.8×10^{11} m B) 2.4×10^{11} m C) 1.2×10^{11} m D) 3.0×10^{11} m

Answer: B

33) The second hand of a clock has a length of 0.30 m. What distance does the tip of the second hand sweep through in 3 minutes and 45 seconds? 33) _____

A) 1.8 m B) 13 m C) 7.1 m D) 1.1 m

Answer: C

34) How many rad/s is 25 revolutions per minute equivalent to? 34) _____

A) 160 rad/s B) 0.42 rad/s C) 240 rad/s D) 2.6 rad/s

Answer: D

35) A bicycle wheel rotates uniformly through 2.0 revolutions in 4.0 s. What is the frequency of the wheel's rotation? 35) _____

A) 0.50 Hz B) 4.0 Hz C) 2.0 Hz D) 1.0 Hz

Answer: A

36) A pulsar (a rotating neutron star) emits pulses at a frequency of 0.40 kHz. The period of its rotation is 36) _____

A) 0.025 s. B) 2.5 s. C) 25 ms. D) 2.5 ms.

Answer: D

37) A phonograph record rotates at 45 rpm. Through what angle does it turn in 0.20 s? 37) _____

A) 96° B) 15° C) 9.0° D) 54°

Answer: D

38) A wheel of diameter 26 cm turns at 1500 rpm. How far will a point on the outer rim move in 2.0 s? 38) _____
A) 90 m B) 41 m C) 3.1 m D) 180 m
Answer: B

39) A bicycle wheel rotates uniformly through 2.0 revolutions in 4.0 s. What is the average angular speed of the wheel? 39) _____
A) 0.79 rad/s B) 1.6 rad/s C) 6.3 rad/s D) 3.1 rad/s
Answer: D

40) A bicycle wheel rotates uniformly through 2.0 revolutions in 4.0 s. What is the linear speed of a point 0.10 m from the center of the wheel? 40) _____
A) 0.16 rad/s B) 0.31 rad/s C) 0.63 rad/s D) 0.079 rad/s
Answer: B

41) A cable car at a ski resort carries skiers a distance of 6.8 km. The cable which moves the car is driven by a pulley with diameter 3.0 m. Assuming no slippage, how fast must the pulley rotate for the cable car to make the trip in 12 minutes? 41) _____
A) 720 rpm B) 60 rpm C) 9.4 rpm D) 30 rpm
Answer: B

42) A wheel of radius 1.0 m is rotating with a constant angular speed of 2.0 rad/s. What is the linear speed of a point on the wheel's rim? 42) _____
A) 2.0 m/s B) 4.0 m/s C) 1.0 m/s D) 0.50 m/s
Answer: A

43) The cutting cord on a gas-powered weed cutter is 0.16 m in length. If the motor rotates at the rate of 20 rev/s, what is the approximate linear speed of the end of the cord? 43) _____
A) 20 m/s B) 65 m/s C) 35 m/s D) 25 m/s
Answer: A

44) A wheel of radius 1.0 m is rotating with a constant angular speed of 2.0 rad/s. What is the centripetal acceleration of a point on the wheel's rim? 44) _____
A) 1.0 m/s^2 B) 0.50 m/s^2 C) 2.0 m/s^2 D) 4.0 m/s^2
Answer: D

45) What is the centripetal acceleration of a point on the perimeter of a bicycle wheel of diameter 70.0 cm when the bike is moving 8.00 m/s? 45) _____
A) 206 m/s^2 B) 266 m/s^2 C) 183 m/s^2 D) 91.0 m/s^2
Answer: C

46) How many revolutions per minute (rpm) must a circular, rotating space station (r = 1000 m) rotate to produce an artificial gravity of 9.80 m/s^2? 46) _____
A) 0.83 rpm B) 0.95 rpm C) 0.094 rpm D) 0.075 rpm
Answer: B

47) A car is negotiating a flat circular curve of radius 50 m with a speed of 20 m/s. The maximum centripetal force (provided by static friction) is 1.2×10^4 N. What is the centripetal acceleration of the car? 47) _____
A) 8.0 m/s^2 B) 0.80 m/s^2 C) 0.40 m/s^2 D) 4.0 m/s^2
Answer: A

48) A car is negotiating a flat circular curve of radius 50 m with a speed of 20 m/s. The maximum centripetal force (provided by static friction) is 1.2×10^4 N. What is the mass of the car? 48) _____

A) 1.5×10^3 kg B) 1.0×10^3 kg C) 2.0×10^3 kg D) 0.50×10^3 kg

Answer: A

49) A 0.300-kg mass, attached to the end of a 0.750-m string, is whirled around in a smooth level table. If the maximum tension that the string can withstand is 250 N, then what maximum linear speed can the mass have if the string is not to break? 49) _____

A) 19.4 m/s B) 32.7 m/s C) 25.0 m/s D) 22.4 m/s

Answer: C

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

50) A bowling ball of mass 7.5 kg and radius 9.0 cm rolls without slipping 10 m down a lane at 4.3 m/s.
(a) Calculate the angular displacement of the bowling ball.
(b) Calculate the angular velocity of the bowling ball.
(c) Calculate the radial acceleration of the bowling ball.
(d) Calculate the tangential acceleration of the bowling ball.

Answer: (a) 110 rad
(b) 48 rad/s
(c) 210 m/s^2
(d) 0 m/s^2

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

51) A wheel accelerates with a constant angular acceleration of 4.5 rad/s^2. If the initial angular velocity is 1.0 rad/s, what is the angle the wheel rotates through in 2.0 s? 51) _____

A) 11 rad B) 9.0 rad C) 4.5 rad D) 7.0 rad

Answer: A

52) A wheel accelerates with a constant angular acceleration of 4.5 rad/s^2. If the initial angular velocity is 1.0 rad/s, what is the angular velocity at t = 2.0 s? 52) _____

A) 10 rad/s B) 1.0 rad/s C) 9.0 rad/s D) 7.0 rad/s

Answer: A

53) How many radians does a 0.300-m radius automobile tire rotate after starting from rest and accelerating at a constant angular acceleration of 2.00 rad/s^2 over a 5.00-s interval? 53) _____

A) 1.00 rad B) 2.00 rad C) 25.0 rad D) 12.5 rad

Answer: C

54) A wheel starts at rest, and has an angular acceleration of 4 rad/s^2. Through what angle does it turn in 3.0 s? 54) _____

A) 12 rad B) 36 rad C) 18 rad D) 9.0 rad

Answer: C

55) A Ferris wheel rotating at 20 rad/s decelerates with a constant angular acceleration of -5.0 rad/s^2. How many revolutions does it rotate before coming to rest? 55) _____

A) 40 B) 6.4 C) 20 D) 3.2

Answer: B

56) A wheel starts from rest and reaches an angular speed of 6.0 rad/s while turning through 2.0 revolutions. What is the average angular acceleration of the wheel? 56) _____

A) 3.0 rad/s^2 B) 0.24 rad/s^2 C) 9.0 rad/s^2 D) 1.4 rad/s^2

Answer: D

57) A wheel of diameter of 68.0 cm slows down uniformly from 8.40 m/s to rest over a distance of 115 m. What is the total number of revolutions the wheel rotates in coming to rest? 57) _____

A) 169 rev B) 338 rev C) 53.8 rev D) 26.9 rev

Answer: C

58) A wheel of diameter of 68.0 cm slows down uniformly from 8.40 m/s to rest over a distance of 115 m. What is the angular acceleration? 58) _____

A) -0.90 rad/s^2 B) -11.3 rad/s^2 C) -5.65 rad/s^2 D) -1.80 rad/s^2

Answer: A

59) A wheel of diameter of 68.0 cm slows down uniformly from 8.40 m/s to rest over a distance of 115 m. How long does it take for the wheel to come to the stop? 59) _____

A) 47.2 s B) 27.4 s C) 42.7 s D) 24.7 s

Answer: B

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

60) A centrifuge in a medical laboratory rotates at a rotational speed of 3600 rev/min. When switched off, it rotates 50.0 times at a constant angular acceleration before coming to rest.
(a) Determine the initial angular speed of the centrifuge.
(b) Determine the angle (in radians) through which the centrifuge rotates before coming to rest.
(c) Calculate the constant angular acceleration of the centrifuge.
(d) Calculate the time necessary for the centrifuge to come to rest.

Answer: (a) 377 rad/s
(b) 314 rad
(c) -226 rad/s^2
(d) 1.67 s

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

61) The bolts on a car wheel require tightening to a torque of 90 N·m. If a 30 cm long wrench is used, what is the magnitude of the force required when the force is perpendicular to the wrench? 61) _____

A) 15 N B) 300 N C) 30 N D) 150 N

Answer: B

62) The bolts on a car wheel require tightening to a torque of 90 N·m. If a 30 cm long wrench is used, what is the magnitude of the force required when the force applied at 53° to the wrench? 62) _____

A) 190 N B) 380 N C) 38 N D) 19 N

Answer: B

63) A wheel with moment of inertia 3.00 kg·m^2 has a net torque of 3.50 N·m applied to it. What angular acceleration does it experience? 63) _____

A) 0.857 rad/s^2 B) 3.50 rad/s^2 C) 1.17 rad/s^2 D) 3.00 rad/s^2

Answer: C

64) A triatomic molecule is modeled as follows: mass m is at the origin, mass 2m is at x = a, and, mass 3m is at x = 2a. What is the moment of inertia about the origin? 64) _____

A) 14 ma^2 B) 3 ma^2 C) 12 ma^2 D) 2 ma^2

Answer: A

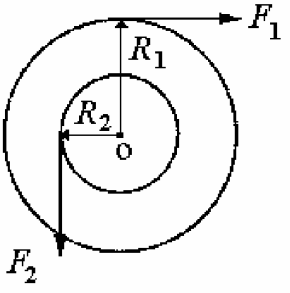

FIGURE 8-1

65) A solid cylinder of mass 10 kg is pivoted about a frictionless axis thought the center O. A rope wrapped around the outer radius R_1 = 1.0 m, exerts a force F_1 = 5.0 N to the right. A second rope wrapped around another section of radius R_2 = 0.50 m exerts a force F_2 = 6.0 N downward. (See Fig. 8-1.) What is the angular acceleration of the cylinder? 65) _____

A) 0.40 rad/s^2 B) 0.80 rad/s^2 C) 1.0 rad/s^2 D) 0.60 rad/s^2

Answer: A

66) A solid cylinder of mass 10 kg is pivoted about a frictionless axis thought the center O. A rope wrapped around the outer radius R_1 = 1.0 m, exerts a force F_1 = 5.0 N to the right. A second rope wrapped around another section of radius R_2 = 0.50 m exerts a force F_2 = 6.0 N downward. How many radians does the cylinder rotate through in the first 5.0 seconds, if it starts from rest? 66) _____

A) 10 rad B) 5.0 rad C) 7.5 rad D) 13 rad

Answer: B

67) A 4.00-m long rod is hinged at one end. The rod is initially held in the horizontal position, and then released as the free end is allowed to fall. What is the angular acceleration as it is released? (The moment of inertia of a rod about one end is $ML^2/3$.) 67) _____

A) 6.75 rad/s^2 B) 3.68 rad/s^2 C) 4.90 rad/s^2 D) 2.45 rad/s^2

Answer: B

68) Consider a bicycle wheel to be a ring of radius 30 cm and mass 1.5 kg. Neglect the mass of the axle and sprocket. If a force of 20 N is applied tangentially to a sprocket of radius 4.0 cm for 4.0 s, what linear speed does the wheel achieve, assuming it rolls without slipping? 68) _____

A) 3.0 m/s B) 24 m/s C) 5.9 m/s D) 7.1 m/s

Answer: D

69) A 1.53-kg mass hangs on a rope wrapped around a frictionless disk pulley of mass 7.07 kg and radius 66.0 cm. What is the angular acceleration of the pulley? 69) _____

A) 9.87 rad/s^2 B) zero C) 4.49 rad/s^2 D) 7.98 rad/s^2

Answer: C

70) A 1.53-kg mass hangs on a rope wrapped around a frictionless disk pulley of mass 7.07 kg and radius 66.0 cm. What is the acceleration of the mass? 70) _____

A) 2.96 m/s^2 B) 9.26 m/s^2 C) zero D) 6.29 m/s^2

Answer: A

71) A rotating flywheel can be used to store energy. If it is required to store 1.00×10^6 J of energy when rotating at 400 rad/s, what is the moment of inertial of the wheel in kg·m^2? 71) _____

A) 12.5 B) 6.25 C) 50.0 D) 25.0

Answer: A

72) A wheel of moment of inertia of 5.00 kg·m^2 starts from rest and accelerates under a constant torque of 3.00 N·m for 8.00 s. What is the wheel's rotational kinetic energy at the end of 8.00 s? 72) _____

A) 122 J B) 57.6 J C) 78.8 J D) 64.0 J

Answer: B

73) A solid sphere of mass 1.0 kg and radius 0.010 m starts from rest and rolls without slipping down a 1.0-m high inclined plane. What is the speed of the sphere when it reaches the bottom of the inclined plane? 73) _____

A) 6.3 m/s B) 4.4 m/s C) 5.6 m/s D) 3.7 m/s

Answer: D

74) A solid sphere of mass 1.0 kg and radius 0.010 m rolls with a speed of 10 m/s. How high up an inclined plane can it climb before coming to rest? 74) _____

A) 7.1 m B) 0.071 m C) 0.71 m D) 71 m

Answer: A

75) A hoop of radius 0.50 m and a mass of 0.20 kg is released from rest and allowed to roll down an inclined plane. How fast is it moving after dropping a vertical distance of 3.0 m? 75) _____

A) 2.2 m/s B) 7.7 m/s C) 3.8 m/s D) 5.4 m/s

Answer: D

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

76) A solid sphere of mass 1.5 kg and radius 15 cm rolls without slipping down a 35° incline that is 7.0 m long. Assume it started from rest. The moment of inertia of a sphere is given by $I = (2/5)MR^2$.
(a) Calculate the linear speed of the sphere when it reaches the bottom of the incline.
(b) Determine the angular speed of the sphere at the bottom of the incline.
(c) Does the linear speed depend on the radius or mass of the sphere? Does the angular speed depend on the radius or mass of the sphere?

Answer: (a) 7.5 m/s
(b) 50 rad/s
(c) The linear speed depends on neither the radius or the mass of the sphere. The angular speed depends on the radius of the sphere.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

77) An object's angular momentum changes by 20 kg·m^2/s in 4.0 s. What magnitude average torque acted on this object? 77) _____

A) 5.0 N·m B) 40 N·m C) 2.5 N·m D) 80 N·m

Answer: A

78) A proton of mass 1.67×10^{-27} kg rotates with an angular speed of 2×10^{6} rad/s in a circle of radius 0.80 m in a cyclotron. What is the orbital angular momentum of the proton? 78) _____

A) 1.28×10^{-21} kg·m^2/s B) 3.20×10^{-21} kg·m^2/s

C) 2.14×10^{-21} kg·m^2/s D) 1.76×10^{-21} kg·m^2/s

Answer: C

79) An ice skater has a moment of inertia of 5.0 kg·m^2 when her arms are outstretched. At this time she is spinning at 3.0 revolutions per second (rps). If she pulls in her arms and decreases her moment of inertia to 2.0 kg·m^2, how fast will she be spinning? 79) _____

A) 7.5 rps B) 3.3 rps C) 10 rps D) 2.0 rps

Answer: A

80) A figure skater rotating at 5.00 rad/s with arms extended has a moment of inertia of 2.25 kg·m^2. If the arms are pulled in so the moment of inertia decreases to 1.80 kg·m^2, what is the final angular speed? 80) _____

A) 4.60 rad/s B) 2.25 rad/s C) 0.81 rad/s D) 6.25 rad/s

Answer: D

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

81) Suppose a disk rotates at constant angular velocity. Does a point on the rim have radial and/or tangential acceleration? If the disk's angular velocity increases uniformly, does the point have radial and/or tangential acceleration? For which cases would the magnitude of either component of linear acceleration change?

Answer: If a disk rotates at constant angular velocity, a point on the rim has radial acceleration only—no tangential acceleration. If the disk's angular velocity increases uniformly, the point will have both radial and tangential acceleration. If the disk rotates at constant angular velocity, neither component of linear acceleration is changing—both radial and tangential acceleration are constant. If the disk rotates with a uniformly increasing angular velocity, then the radial acceleration is changing, but the tangential acceleration is a constant non-zero value.

82) Can a small force ever exert a greater torque than a larger force? Explain.

Answer: Since the torque involves the product of force times lever arm, a small force can exert a greater torque than a larger force if the small force has a large enough lever arm.

83) If the net force on a system is zero, is the net torque also zero? If the net torque on a system is zero, is the net force zero?

Answer: Just because the net force on a system is zero, the net torque need not be zero. Just because the net torque on a system is zero, the net force need not be zero.

84) Two solid spheres simultaneously start rolling (from rest) down an incline. One sphere has twice the radius and twice the mass of the other. Which reaches the bottom of the incline first? Which has the greater speed there? What has the greater total kinetic energy at the bottom?

Answer: The speed is independent of the mass and radius of the ball, so both balls will have the same speed at the bottom. In fact, this is true for ANY height of fall, the two balls will have identical instantaneous speeds all along their descent, and so both balls will take the same time to reach the bottom. The ball with the larger mass has the greater total kinetic energy.

85) Suppose you are sitting on a rotating stool holding a 2-kg mass in each outstretched hand. If you suddenly drop the masses, will your angular velocity increase, decrease, or stay the same? Explain.

Answer: Your angular velocity will not change. Before you let go of the masses, your body has a certain angular momentum, which is the product of your moment of inertia and your angular velocity. No torques are put upon you by the act of dropping the masses, and so your angular momentum does not change. If you don't change your moment of inertia by changing the position of your body, then your angular velocity will not change. The masses, when dropped, will have a horizontal motion that is tangential to the circle in which they were moving before they were dropped. An object traveling horizontally at some distance from a vertical line (like your axis of rotation) has angular momentum relative to that vertical line. The masses keep the angular momentum that they had before being dropped.

86) Suppose you are standing on the edge of a large freely rotating turntable. What happens if you walk toward the center?

Answer: The angular momentum of the turntable - person system will be conserved, since no external torques are being applied as the person walks to the center. As the person walks to the center, the overall moment of inertia of the system gets smaller, since the person is closer to the axis of rotation. Since the angular momentum is constant, the angular velocity must increase. So the turntable will begin to rotate faster as you walk to the center. This is similar to the spinning ice skater who pulls her arms in to increase her angular speed.

87) (a) A grinding wheel 0.35 m in diameter rotates at 2500 rpm. Calculate its angular velocity in rad/s. (b) What are the linear speed and acceleration of a point on the edge of the grinding wheel?

Answer: (a) 2.6×10^2 rad/s

(b) 46 m/s, 1.2×10^4 m/s^2

88) A rotating merry-go-round makes one complete revolution in 4.0 s. (a) What is the linear speed of a child seated 1.2 m from the center? (b) What is her acceleration (give components)?

Answer: (a) 1.9 m/s

(b) The acceleration is radial. There is no tangential acceleration. 3.0 m/s^2 toward the center

89) A 70-cm diameter wheel accelerates uniformly about its center from 130 rpm to 280 rpm in 4.0 s. Determine (a) its angular acceleration, and (b) the radial and tangential components of the linear acceleration of a point on the edge of the wheel 2.0 s after it had started accelerating.

Answer: (a) 3.9 rad/s^2

(b) 1.6×10^2 m/s^2, 1.4 m/s^2

90) In traveling to the Moon, astronauts aboard the *Apollo* spacecraft put themselves into a slow rotation to distribute the Sun's energy evenly. At the start of their trip, they accelerated from no rotation to 1.0 revolution every minute during a 12 min time interval. The spacecraft can be thought of as a cylinder with a diameter of 8.5 m. Determine (a) the angular acceleration, and (b) the radial and tangential components of the linear acceleration of a point on the skin of the ship 5.0 min after it started this acceleration.

Answer: (a) 1.5×10^{-4} rad/s^2

(b) 8.1×10^{-3} m/s^2, 6.2×10^{-4} m/s^2

91) A cooling fan is turned off when it is running at 850 rev/min. It turns 1500 revolutions before it comes to a stop. (a) What was the fan's angular acceleration, assumed constant? (b) How long did it take the fan to come to a complete stop?

Answer: (a) -0.42 rad/s^2

(b) 210 s

92) The tires of a car make 65 revolutions as the car reduces its speed uniformly from 95 km/h to 45 km/h. The tires have a diameter of 0.80 m. (a) What was the angular acceleration of the tires? (b) If the car continues to decelerate at this rate, how much more time is required for it to stop?

Answer: (a) -4.1 rad/s^2
(b) 7.6 s

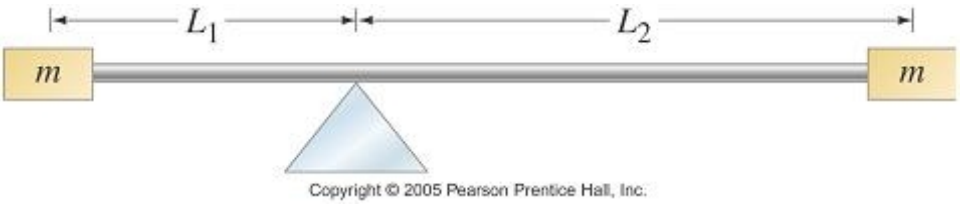

FIGURE 8-40

93) Two blocks, each of mass *m*, are attached to the ends of a massless rod which pivots as shown in Fig. 8-40. Initially the rod is held in the horizontal position and then released. Calculate the magnitude and direction of the net torque on this system.

Answer: $mg\,(L_2 - L_1)$, clockwise

94) A small 650-gram ball on the end of a thin, light, rod is rotated in a horizontal circle of radius 1.2 m. Calculate (a) the moment of inertia of the ball about the center of the circle, and (b) the torque needed to keep the ball rotating at constant angular velocity if air resistance exerts a force of 0.020 N on the ball. Ignore the rod's moment of inertia and air resistance.

Answer: (a) 0.94 kg m^2
(b) 2.4×10^{-2} m N

95) A softball player swings a bat, accelerating it from rest to 3.0 rev/s in a time of 0.20 s. Approximate the bat as a 2.2 kg uniform rod of length 0.95 m, and compute the torque the player applies to one end of it.

Answer: 62 m N

96) A centrifuge rotor rotating at 10,300 rpm is shut off and is eventually brought uniformly to rest by a frictional torque of 1.20 m N. If the mass of the rotor is 4.80 kg and it can be approximated as a solid cylinder of radius 0.0710 m, through how many revolutions will the rotor turn before coming to rest, and how long will it take?

Answer: 993 rev, 10.9 s

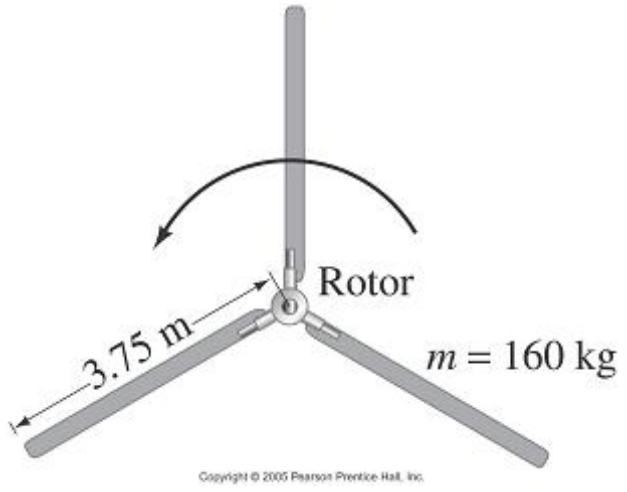

FIGURE 8-46

97) A helicopter rotor blade can be considered a long thin rod, as shown in Fig. 8-46. (a) If each of the three rotor helicopter blades is 3.75 m long and has a mass of 160 kg, calculate the moment of inertia of the three rotor blades about the axis of rotation. (b) How much torque must the motor apply to bring the blades up to a speed of 5.0 rev/s in 8.0 s?

Answer: (a) 2.3×10^2 kg m^2
(b) 8.8×10^3 m N

98) A bowling ball of mass 7.3 kg and radius 9.0 cm rolls without slipping down a lane at 3.3 m/s. Calculate it total kinetic energy.

Answer: 56 J

99) A sphere of radius 20.0 cm and mass 1.80 kg starts from rest and rolls without slipping down a 30.0° incline that is 10.0 m long. (a) Calculate its translational and rotational speeds when it reaches the bottom. (b) What is the ratio of translational to rotational KE at the bottom? Avoid putting in numbers until the end so you can answer: (c) do your answers in (a) and (b) depend on the radius of the sphere or its mass?

Answer: (a) 8.37 m/s, 41.8 rad/s
(b) 2.5
(c) Only the angular speed depends on the radius. None of the results depend on the mass.

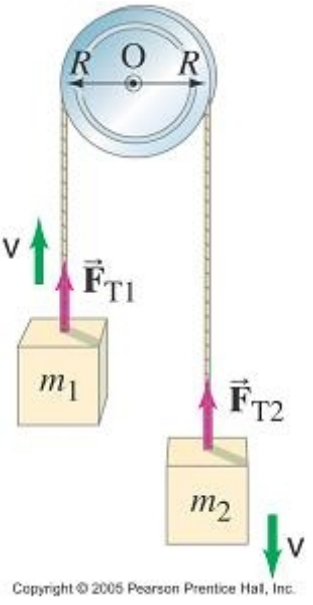

FIGURE 8-47

100) Two masses, m_1 = 18.0 kg and m_2 = 26.5 kg, are connected by a rope that hangs over a pulley (as in Fig. 8-47). The pulley is a uniform cylinder of radius 0.260 m and mass 7.50 kg. Initially, m_1 is on the ground and m_2 rests 3.00 m above the ground. If the system is now released, use conservation of energy to determine the speed of m_2 just before it strikes the ground. Assume the pulley if frictionless.

Answer: 3.22 m/s

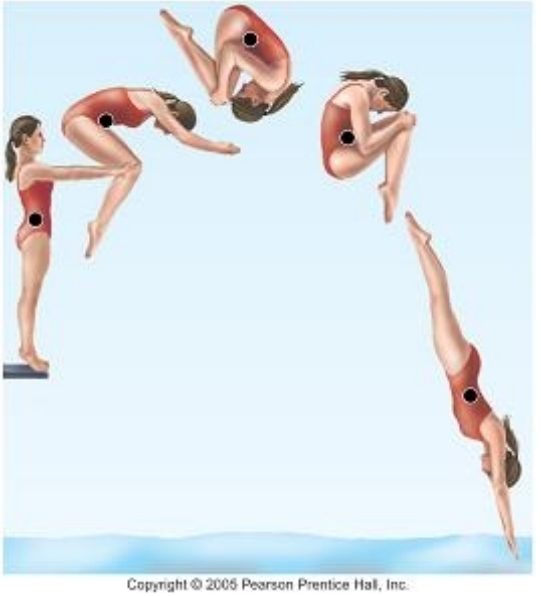

FIGURE 8-29

101) A diver (such as the one shown in Fig. 8-29) can reduce her moment of inertia by a factor of about 3.5 when changing from the straight position to the tuck position. If she makes 2.0 rotations in 1.5 s when in the tuck position, what is her angular speed (rev/s) when in the straight position?

Answer: 0.38 rev/s

102) A potter's wheel is rotating around a vertical axis through its center at a frequency of 1.5 rev/s. The wheel can be considered a uniform disk of mass 5.0 kg and diameter 0.40 m. The potter then throws a 3.1 kg chunk of clay, approximately shaped as a flat disk of radius 8.0 cm, onto the center of the rotating wheel. What is the frequency of the wheel after the clay sticks to it?

Answer: 1.4 rev/s

103) (a) What is the angular momentum of a figure skater spinning at 3.5 rev/s with arms in close to her body, assuming her to be a uniform cylinder with a height of 1.5 m, a radius of 15 cm, and a mass of 55 kg? (b) How much torque is required to slow her to a stop in 5.0 s, assuming she does *not* move her arms?

Answer: (a) 14 kg m/s^2
(b) -2.7 m N

104) A person of mass 75 kg stands at the center of a rotating merry-go-round platform of radius 3.0 m and moment of inertia 920 kg m^2. The platform rotates without friction with angular velocity 2.0 rad/s. The person walks radially to the edge of the platform. (a) Calculate the angular velocity when the person reaches the edge. (b) Calculate the rotational kinetic energy of the system of platform plus person before and after the person's walk.

Answer: (a) 1.2 rad/s
(b) 1.8×10^3 J, 1.1×10^3 J

105) 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 kg m^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.

Answer: -0.30 rad/s