AP Physics 1   Rotational Motion   Practice Test

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

1) A spinning ice skater on extremely smooth ice is able to control the rate at which she rotates by pulling in her arms. Which of the following statements are true about the skater during this process? (There could be more than one correct choice.)
    A) Her angular momentum remains constant.   B) Her kinetic energy remains constant.
    C) Her moment of inertia remains constant.   D) She is subject to a constant non–zero torque.

2) The moment of inertia of a solid cylinder about its axis is given by $0.5MR^2$. If this cylinder rolls without slipping, the ratio of its rotational kinetic energy to its translational kinetic energy is
    A) 3:1   B) 1:2   C) 1:3   D) 2:1   E) 1:1

3) If a constant net torque is applied to an object, that object will
    A) rotate with constant linear velocity.
    B) having an increasing moment of inertia.
    C) rotate with constant angular velocity.
    D) having a decreasing moment of inertia.
    E) rotate with constant angular acceleration.

4) A disk, a hoop, and a solid sphere are released at the same time at the top of an inclined plane. They are all uniform and roll without slipping. In what order do they reach the bottom?
    A) hoop, sphere, disk
    B) hoop, disk, sphere
    C) sphere, disk, hoop
    D) disk, hoop, sphere
    E) sphere, hoop, disk

5) Two equal–magnitude forces are applied to a door at the doorknob. The first force is applied perpendicular to the door, and the second force is applied at 30° to the plane of the door. Which force exerts the greater torque about the door hinge?
    A) the first force (applied perpendicular to the door)
    B) the second force (applied at an angle)
    C) Both forces exert zero torque.
    D) Both forces exert equal non–zero torques.

6) An object's angular momentum changes by $10 \ \text{kg–m}^2/\text{s}$ in 2.0 s. What magnitude average torque acted on this object?
    A) 5 N–m   B) 20 N–m   C) 2.5 N–m   D) 10 N–m   E) 40 N–m

7) Suppose a solid uniform 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
    A) the mass of the sphere.   B) the radius of the sphere.
    C) both the mass and the radius of the sphere.   D) neither the mass nor the radius of the sphere.

8) A solid sphere and a solid cylinder, both uniform and of the same mass and radius, roll without slipping at the same forward speed. It is correct to say that the total kinetic energy of the solid sphere is
    A) less than the total kinetic energy of the cylinder.
    B) equal to the total kinetic energy of the cylinder.
    C) more than the total kinetic energy of the cylinder.

9) A force of 17 N is applied to the end of a 0.63–m long torque wrench at an angle 45° from a line joining the pivot point to the handle. What is the magnitude of the torque about the pivot point produced by this force?
    A) 10.7 N · m   B) 9.7 N · m   C) 12.0 N · m   D) 7.6 N · m

10) How long does it take for a rotating object to speed up from 15.0 rad/s to 33.3 rad/s if it has a uniform angular acceleration of 3.45 rad/s^2?
    A) 4.35 s   B) 5.30 s   C) 10.6 s   D) 63.1 s   E) 9.57 s

11) A boy and a girl are balanced on a massless seesaw. The boy has a mass of 60 kg and the girl's mass is 50 kg. If the boy sits 1.5 m from the pivot point on one side of the seesaw, where must the girl sit on the other side for equilibrium?
    A) 1.8 m   B) 1.3 m   C) 2.5 m   D) 3.0 m   E) 1.2 m

12) A pulley has an initial angular speed of 12.5 rad/s and a constant angular acceleration of 3.41 rad/s^2. Through what angle does the pulley turn in 5.26 s?
    A) 113 rad   B) 22.6 rad   C) 19.3 rad   D) 160 rad   E) 42.6 rad

13) Angular momentum cannot be conserved if
    A) there is a net force on the system.
    B) the angular displacement changes.
    C) the moment of inertia changes.
    D) there is net torque on the system.
    E) the angular velocity changes.

14) When a fan is turned off, its angular speed decreases from 10 rad/s to 6.3 rad/s in 5.0 s. What is the magnitude of the average angular acceleration of the fan?
    A) 1.2 rad/s^2 B) 0.86 rad/s^2 C) 0.74 rad/s^2 D) 11 rad/s^2 E) 0.37 rad/s^2

15) The figure shows a person's foot. In that figure, the Achilles tendon exerts a force of magnitude $F = 720$ N. What is the magnitude of the torque that this force produces about the ankle joint?
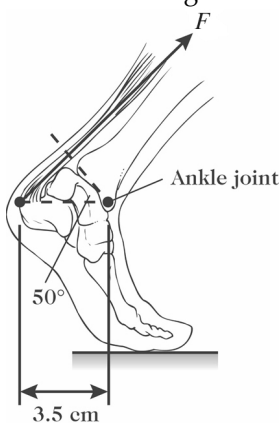

    A) 26 N · m   B) 36 N · m   C) 16 N · m   D) 21 N · m   E) 12 N · m

16) 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?

    A) 91.9 J   B) 78.8 J   C) 122.0 J   D) 57.6 J   E) 64.0 J

17) A string is wound tightly around a fixed pulley having a radius of 5.0 cm. As the string is pulled, the pulley rotates without any slipping of the string. What is the angular speed of the pulley when the string is moving at 5.0 m/s?

    A) 25 rad/s   B) 100 rad/s   C) 20 rad/s   D) 10 rad/s   E) 50 rad/s

18) The rotating systems shown in the figure differ only in that the two identical movable masses are positioned a distance r from the axis of rotation (left), or a distance $r/2$ from the axis of rotation (right). If you release the hanging blocks simultaneously from rest,
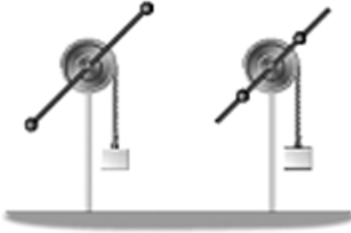

    A) the block at the left lands first.
    B) both blocks land at the same time.
    C) the block at the right lands first.

19) Consider a solid uniform sphere of radius R and mass M rolling without slipping. Which form of its kinetic energy is larger, translational or rotational?

    A) Rotational kinetic energy is larger.
    B) Both are equal.
    C) Translational kinetic energy is larger.
    D) You need to know the speed of the sphere to tell.

20) When is the angular momentum of a system constant?

    A) Only when the linear momentum and the energy are constant.
    B) Only when no net external torque acts on the system.
    C) Only when its total kinetic energy is constant.
    D) Only when no net external force acts on the system.
    E) Only when the moment of inertia is constant.

21) Two forces produce equal torques on a door about the door hinge. 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 has a greater magnitude?

    A) the first force (at the midpoint)
    B) the second force (at the doorknob)
    C) The two forces are equal.

22) Five forces act on a rod that is free to pivot at point P, as shown in the figure. Which of these forces is producing a counter–clockwise torque about point P? (There could be more than one correct choice.)
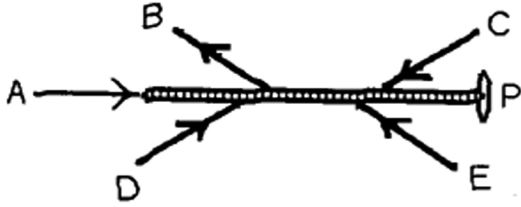
A) force A   B) force B   C) force C   D) force D   E) force E

23) Two uniform solid balls, one of radius R and mass M, the other of radius $2R$ and mass $8M$, roll down a high incline. They start together from rest at the top of the incline. Which one will reach the bottom of the incline first?
    A) The large sphere arrives first.
    B) The small sphere arrives first.
    C) Both reach the bottom at the same time.

24) A merry–go–round spins freely when Diego moves quickly to the center along a radius of the merry–go–round. As he does this, it is true to say that
    A) the moment of inertia of the system decreases and the angular speed increases.
    B) the moment of inertia of the system decreases and the angular speed remains the same.
    C) the moment of inertia of the system decreases and the angular speed decreases.
    D) the moment of inertia of the system increases and the angular speed increases.
    E) the moment of inertia of the system increases and the angular speed decreases.

25) 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?
    A) It decreases.
    B) It changes, but it is impossible to tell which way.
    C) It does not change.
    D) It increases.

26) The figure shows scale drawings of four objects, each of the same mass and uniform thickness, with the mass distributed uniformly. Which one has the greatest moment of inertia when rotated about an axis perpendicular to the plane of the drawing at point P?
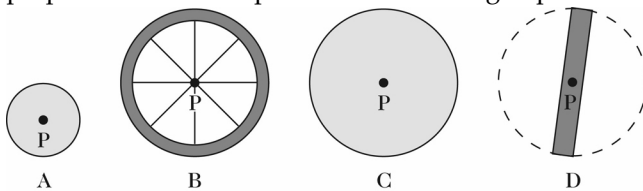
    A) A
    B) B
    C) C
    D) D
    E) The moment of inertia is the same for all of these objects.

27) Consider a uniform hoop of radius R and mass M rolling without slipping. Which is larger, its translational kinetic energy or its rotational kinetic energy?
   A) Both are equal.
   B) Rotational kinetic energy is larger.
   C) Translational kinetic energy is larger.
   D) You need to know the speed of the hoop to tell.

28) What condition or conditions is/are necessary for static equilibrium?
   A) $\Sigma F_x = 0$
   B) $\Sigma F_x = 0$, $\Sigma F_y = 0$
   C) $\Sigma F_y = 0$
   D) $\Sigma \tau = 0$
   E) $\Sigma F_x = 0$, $\Sigma F_y = 0$, $\Sigma \tau = 0$

29) A solid sphere, solid cylinder, and a hollow pipe all have equal masses and radii. If the three of them are released simultaneously at the top of an inclined plane and do not slip, which one will reach the bottom first?
   A) sphere
   B) cylinder
   C) pipe
   D) The pipe and cylinder arrive together before the sphere.
   E) They all reach the bottom at the same time.

30) Consider a rigid body that is rotating. Which of the following is an accurate statement?
   A) Its center of rotation must be moving with a constant velocity.
   B) Its center of rotation must be at rest, i.e., not moving.
   C) All points on the body are moving with the same angular velocity.
   D) All points on the body are moving with the same linear velocity.
   E) Its center of rotation is its center of gravity.

31) A planet of constant mass orbits the sun in an elliptical orbit. Neglecting any friction effects, what happens to the planet's rotational kinetic energy about the sun's center?
   A) It remains constant.
   B) It decreases continually.
   C) It increases continually.
   D) It decreases when the planet approaches the sun, and increases when it moves farther away.
   E) It increases when the planet approaches the sun, and decreases when it moves farther away.

FRQ (20 points)

32) 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?

1) A
2) B
3) E
4) C
5) A
6) A
7) B
8) A
9) D
10) B
11) A
12) A
13) D
14) C
15) C
16) D
17) B
18) C
19) C
20) B
21) A
22) C
23) C
24) A
25) C
26) B
27) A
28) E
29) A
30) C
31) E
32) (a) 7.5 m/s
   (b) 50 rad/s
   (c) The linear speed depends on neither the radius nor the mass of the sphere. The angular speed depends on the radius of the sphere.