

Rotational Motion Studyguide

AP 1 Physics

Name _____

Multiple Choice— Choose the correct answer for each question. No partial credit will be given.

1. An ice skater is spinning about a vertical axis with her arms fully extended. If her arms are pulled in closer to her body, in which of the following ways are the angular momentum and kinetic energy of the skater affected?

<u>Angular Momentum</u>	<u>Kinetic Energy</u>
A) Increases	Increases
B) Increases	Remains constant
C) Remains constant	Increases
D) Remains constant	Remains constant

Questions 2-4:

A solid cylinder rotates with constant angular acceleration about a fixed axis. The cylinder's moment of inertia (I) about the axis is $4.0 \text{ kg}\cdot\text{m}^2$. At time $t = 0 \text{ s}$, the cylinder is at rest. At time, $t = 2.0 \text{ s}$, its angular velocity is 4.0 rad/s .

2. What is the angular acceleration of the cylinder between $t = 0 \text{ s}$ and $t = 2 \text{ s}$?

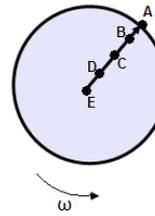
- A) 0.5 rad/s^2
 B) 1.0 rad/s^2
 C) 2.0 rad/s^2
 D) 4.0 rad/s^2

3. What is the angular momentum of the cylinder at $t = 2 \text{ s}$?

- A) $4.0 \text{ kg}\cdot\text{m}^2/\text{s}$
 B) $8.0 \text{ kg}\cdot\text{m}^2/\text{s}$
 C) $16 \text{ kg}\cdot\text{m}^2/\text{s}$
 D) It cannot be determined without knowing the radius of the cylinder.

4. What is the rotational kinetic energy of the cylinder at $t = 2 \text{ s}$?

- A) 4 J
 B) 16 J
 C) 32 J
 D) It cannot be determined without knowing the radius of the cylinder .

Questions 5-6:

5. A solid disc with a radius, R , rotates at a constant rate, ω . Which of the points on the above diagram have the greatest angular velocity?

- A) A
 B) B
 C) C
 D) Points A, B and C have the same angular velocity.

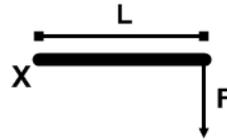
6. A solid disc with a radius, R , rotates at a constant rate, ω . Which of the points on the above diagram have the greatest linear velocity?

- A) A
 B) B
 C) C
 D) Points A, B and C have the same linear velocity

7. A bowling ball of mass, M and radius, R , whose moment of inertia about its center is $\frac{2}{5}MR^2$, rolls without slipping along a level surface at a speed, v . It then encounters an incline and rolls up the incline. What is the maximum vertical height it will reach on the incline?

- A) $\frac{v^2}{5g}$
 B) $\frac{2v^2}{5g}$
 C) $\frac{v^2}{2g}$
 D) $\frac{7v^2}{10g}$

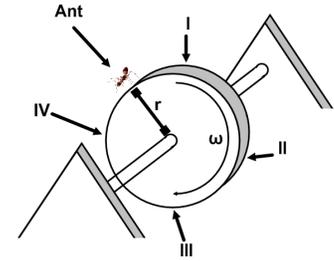
8. In which of the following diagrams is the torque about point O equal in magnitude to the torque about point X in the diagram to the right?



- A)
- B)
- C)
- D)

Questions 9-10:

An ant of mass, m clings to the rim of a flywheel of radius, r as shown above. The flywheel rotates clockwise on a horizontal shaft with a constant angular velocity, ω . As the wheel rotates, the ant revolves past the stationary reference points I, II, III and IV. The ant has very sticky feet and can adhere to wheel with a friction force much greater than its own weight.



9. It will be most difficult for the ant to adhere to the wheel as it revolves past which point?

- A) I
B) II
C) III
D) IV

10. What is the magnitude of the minimum adhesion friction force necessary for the ant to stay on the flywheel at point III?

- A) mg
B) $m\omega^2 r^2 + mg$
C) $m\omega^2 r^2 - mg$
D) $m\omega^2 r + mg$

Multi-Correct: For each of the questions or incomplete statements below, two of the suggested answers will be correct. For each of these questions, you must select both correct choices to earn credit. No partial credit will be earned if only one correct choice is selected. Select the two that are best in each case and then enter both of the appropriate letters in the corresponding space on the answer sheet.

11. Which of the following statements are true regarding the moment of inertia?

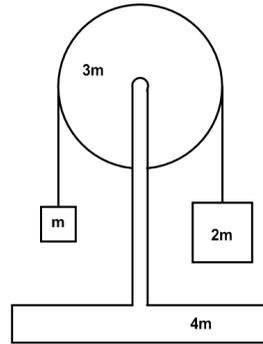
- A) It is a measurement of resistance to angular acceleration due to an applied torque.
B) It is a constant.
C) It depends on the placement of the axis of rotation.
D) For a given torque, an object with a larger moment of inertia will have a larger angular acceleration than one with a smaller moment of inertia.

12. Angular momentum:

- A) is always conserved.
B) is the product of the moment of inertia and the angular velocity.
C) changes if an external torque acts upon the object.
D) stays the same if an external torque acts up the object.

Free Response - Solve this problem, showing all work. Partial credit may be given.

A pulley of mass $3m$ and radius r is mounted on frictionless bearings and supported by a stand of mass $4m$ at rest on a table as shown to the right. The moment of inertia of this pulley about its axis is $\frac{3}{2}mr^2$. Passing over the pulley is a massless cord supporting a block of mass m on the left and a block of mass $2m$ on the right. The cord does not slip on the pulley, so after the block-pulley system is released from rest, the pulley begins to rotate. Answer all questions in terms of m , r , and g .



- a. On the diagrams below, draw and label all the forces acting on the blocks and the pulley.

m

$2m$

$3m$

- b. Use the free body diagrams to write each of the following.
- The equations of translational motion for the two blocks.
 - The analogous equation for the rotational motion of the pulley.
- c. Solve the equations in part b for the acceleration of the two blocks.
- d. Determine the tension force in the segment of the cord attached to the block with mass m .
- e. Determine the tension force in the segment of the cord attached to the block with mass $2m$.
- f. Determine the normal force exerted on the apparatus by the table while the blocks are in motion.