Unit 8: Rotary Motion
PreTest Guide:

1. Angular Displacement is measured in Radians, degree's, and/or revolutions. The best answer is the standard unit for Angular displacement, Radians.

2. The ice skater changes her arm and leg positions and thus increases her moment of inertia (I) thus reducing her angular velocity, because angular momentum is conserved due to no outside forces being applied

3. Angular acceleration is the change in angular velocity per time period. Thus:

   $\alpha = \omega / t$ rad/s / s = rad / s^2

4. They both go around the merry-go-round in the same amount of time. Therefore they both have the same angular velocity, but their linear velocity may be different (hint, hint)

5. The clue here is that the merry-go-round is turning at a constant rate, thus no angular acceleration. Therefore both the boy and girl have zero tangential acceleration.

6. 25 rev / min is converted by factor labeling.

   $$25 \frac{\text{rev}}{\text{min}} \times \frac{2\pi \text{ rad}}{1 \text{ rev}} \times \frac{1 \text{ min}}{60 \text{ sec}} = \underline{\hspace{3cm}} \text{ rad/sec}$$

7. Choose an axis of rotation, typically at one end or at the center under the 50 N force. Determine the law of torques and solve. i.e. with axis at the left end.

   Clockwise torque = Counterclockwise torque

   (X • 10 cm) + (Y •20 cm) + (Z • 40 cm) = (50 N • 30 cm)

8. Two equal forces but one is at an angle. The one at an angle will produce a component that is smaller than the force used. Therefore the smaller force will produce a smaller torque.

9. Clockwise torque = counterclockwise torque

   ? x 75 cm = 38.8 g x 100 cm

   Check the answers units. Change 38.8 grams into newton's and then solve for the question mark "?".

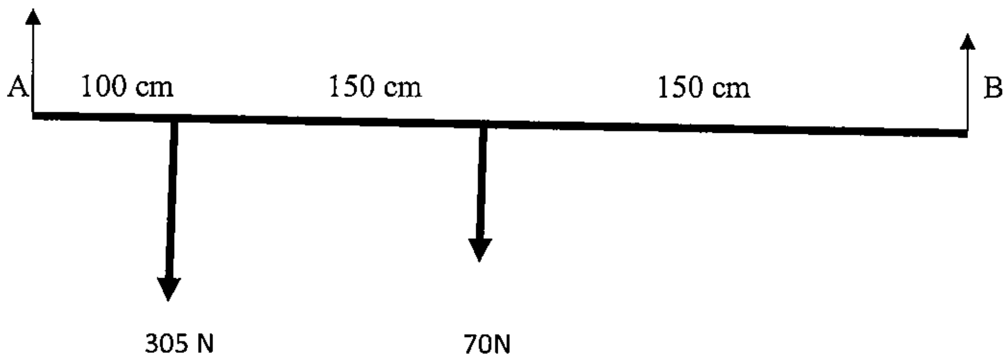
10. Inertia is always the resistance to changes in rotation and/or motion.

11. The uniform solid sphere has a moment of inertia of $I = 2/5\ mr^2$

Increasing mass to 2 m and r to 3r. $I = 2/5\ 2\ m\ (3r)^2$: $I = 2/5\ 2m\ 9r^2$: $I = 2/5\ mr^2 \times 18$

12. No outside forces are applied; thus the angular momentum does not change.

13. Draw out the diagram before reviewing answers.



Put the axis of rotation at point "B" and then set up clockwise torque vs. counterclockwise torque.

14. Between the two riders on the merry-go-round the one who has the largest centripetal acceleration is the one that has the largest linear velocity. The one sitting on the outside of the merry-go-round experiences the largest linear velocity.

15. Use the formula $V = \omega \bullet r$

16. Use the formula : $a_c = V^2 / r$ $a_c = (\omega \bullet r)^2 / r$

17. Oversized tires cause the speedometer to read low because the number of revolutions to go a specific distance is smaller than normal sized tires. The tire will complete fewer revolutions, consequently indicating a slower speed than the car is actually moving. (watch out for tickets)

18. Centripetal acceleration is $9.8\ m/s^2$, use the following formula $a_c = (\omega \bullet r)^2 / r$ and solve for "ω". Convert to revolutions.

19. $L = I\omega$ Units of Angular Momentum are $L = kg\ m^2 \times rad/sec = kg\ m^2 / sec$

20. The best unit to express angular velocity is the standard unit, rad/sec

21. Use the formula: $\theta = S / r$ = 10 m / .09 m = 111.11 m/s

22. Use the formula: $V = \omega \cdot r$

23. Correct method to solve this is:
   a. Calculate circumference of bowling ball = 0.5652 m / rev
   b. Calculate the time the ball goes 10 meters. 2.33 seconds V = S/t
   c. Calculate the number of revolutions the ball makes. 17.693 rev (10 m / 0.5652 m/rev)
   d. Calculate the angular velocity 17.693 rev / 2.33 seconds = 7.59 rev/s = 47.69 rad/sec
   e. Use Radial acceleration formula:

   $$a_r = (\omega \cdot r)^2 / r$$

   f. Or you could skip all of the above and use the equation

   $$a_r = V^2 / r = (4.3 m/s)^2 / 0.09 m$$

24. Use the formula for tangential acceleration :

$$a_t = r \cdot \alpha$$

Since the ball is moving at a constant angular speed, the ball is not accelerating, thus α = zero, and hence the tangential acceleration is zero.

25. You are looking for an angular displacement θ : Write down all of the givens:

$r = 0.300$ meters
$t = 5.0$ seconds
$\omega_o = 0$ rad/sec
$\alpha = 2.0$ rad/sec^2
$\theta = ?$

$$\theta = \omega_o \cdot t + \tfrac{1}{2} \alpha t^2$$

26. Identify given values via GUESS method and use the following formula to solve.

$\omega_f = 0$ rad/sec
$\omega_o = 20$ rad/sec
$\alpha = 2.0$ rad/sec^2
$\theta = ?$

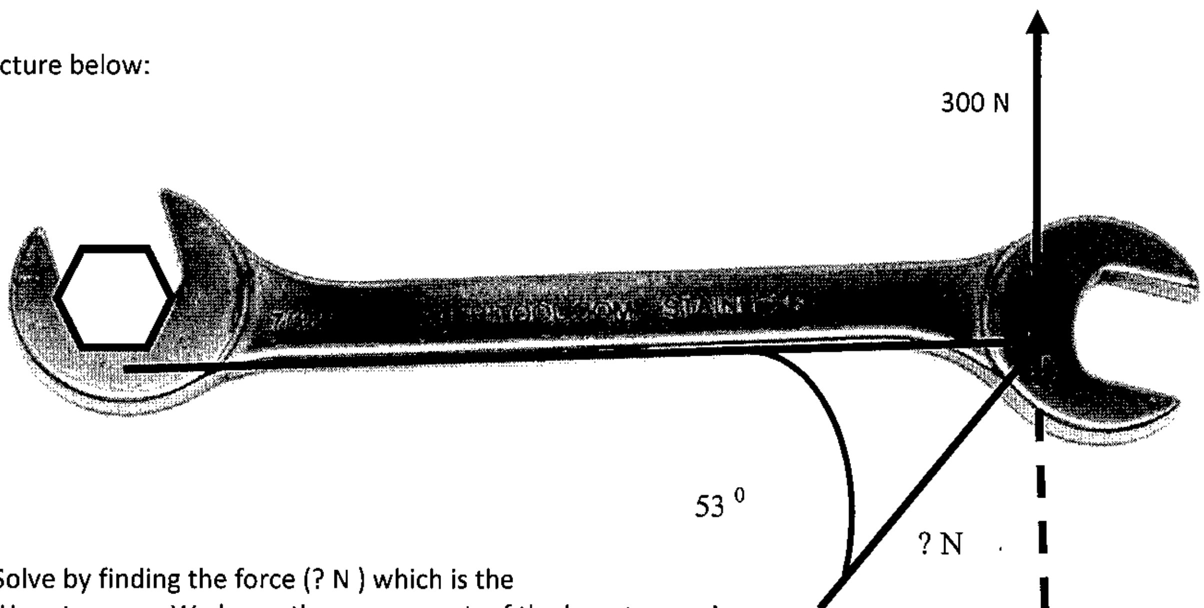
$$\omega_f^{\ 2} = \omega_o^{\ 2} + 2\alpha\theta$$

27. As far as angular displacement is concerned, they both travel through the same number of radians and/or revolutions. Therefore they both have the same angular displacement

28. As far as linear speed, the one that sits on the outside has the greatest linear speed because the one on the outside travels farther in the same time period as someone sitting on the inside of the merry-go-round.

29. Torque = F • L : Therefore 90 N m = F • 0.30 m F = 300 N

30. See picture below:



Solve by finding the force (? N) which is the Hypotenuse. We know the component of the hypotenuse is 300 N to produce a torque of 90 N m. Therefore the hypotenuse should be larger than the component sides.

31. Look at the diagram and identify clockwise vs. counter clockwise torques.

Clockwise	Counter Clockwise
5 N x 1 m	6 N x 0.5 m
5 N m	3 N m

Since the Clockwise is more than the counter clockwise by 2 Nm it will cause an angular acceleration. Look at the formula.

$\tau = I\ \alpha$ The problem tells you that it is a solid cylinder, so $I = \frac{1}{2} mr^2$

Substitute into this equation and solve for angular acceleration.

32. Always the one with the smallest moment of inertia.

33. Use the formula $L = \tau \cdot t$

34. Use the concept of the conservation of angular momentum:

Before	=	After
L_1	=	L_2
$I\,\omega$	=	$I\,\omega$
$2.25\ \text{kg m}^2 \cdot 5\ \text{rad/s}$	=	$1.8\ \text{kg m}^2 \cdot \omega$

35. You should not need to look here. If you don't know this one by now, all hope is lost?