Physics: Rotary Motion **Copy#: ______________**
Unit 8: Pre-Test

<u>Directions</u>: Use provided formula and conversion sheets provided. DO NOT write on this Pre-test if you wish to do your best on the actual test. I will not collect this pre-test, but writing on it will put you at a disadvantage for studying. Each question is worth 2 pts. You will have one class period to complete the actual test, therefore time yourself appropriately and don't spend too much time on any one question.

1) Angular displacement is usually express in units of
A) meters.
B) radians.
C) revolutions.
D) rad/sec

2) An Ice Skater, as pictured goes from position "A" to position "B".
The following is the best description of what happens:
A) angular velocity increases
B) angular momentum decreases
C) moment of inertia increases
D) moment of inertia decreases

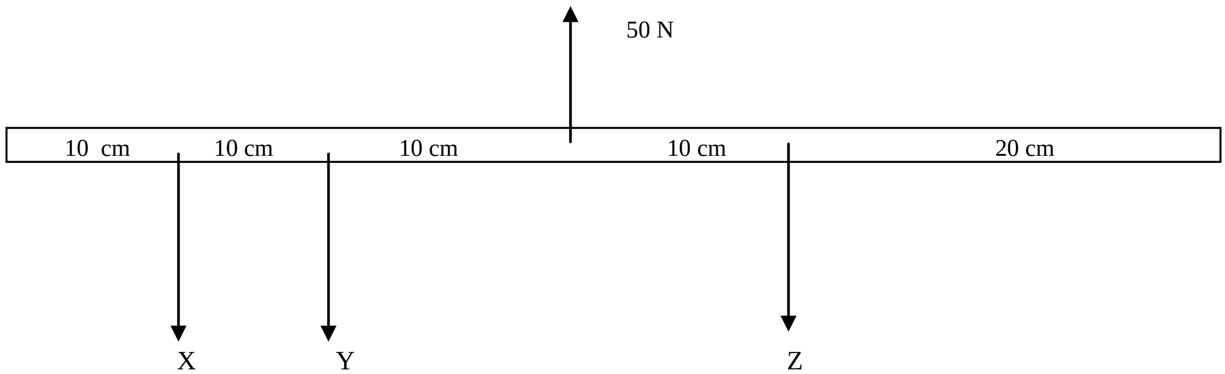

A B

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

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 speed?
A) the boy
B) the girl
C) Both have the same non-zero angular velocity.
D) Both have zero angular velocity.

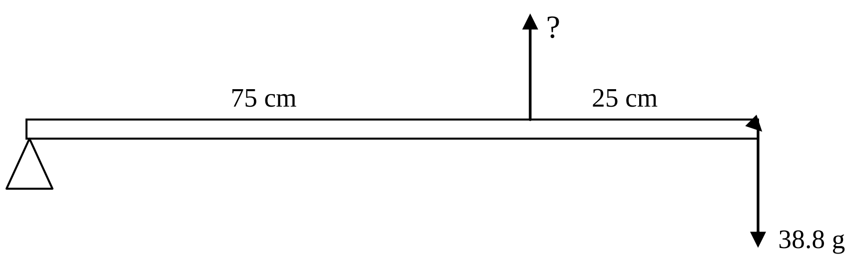
5) A boy and a girl are riding a merry-go-round which is turning at a constant rate. The boy is near the outer edge, while the girl is closer to the center. Who has the greater tangential acceleration?
A) the boy
B) the girl
C) Both have the same non-zero tangential acceleration.
D) Both have zero tangential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

6) How many rad/s is 25 revolutions per minute equivalent to?
A) 0.42 rad/s
B) 2.6 rad/s
C) 160 rad/s
D) 240 rad/s



7) If in the above diagram; “X” = 10 N and “Y” = 10 N, what must be the value of “Z” for rotational equilibrium to be maintained?
A) 50 N B) 45 N C) 37.5 N D) 30 N

8) 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?
A) the first applied perpendicular to the door
B) the second applied at an angle
C) both exert equal non-zero torques
D) both exert zero torques



9) In the above diagram, to produce equilibrium, what upward force must be exerted 0.75 m from the pivoted end?
A) 0.50 N B) 0.75 N C) 1.00 N D) 1.50 N

10) What is the quantity used to measure an object's resistance to changes in rotation?
A) mass B) moment of inertia C) torque D) angular velocity

11) 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?
A) increases by a factor of 6
B) increases by a factor of 12
C) increases by a factor of 18
D) increases by a factor of 54

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

13) The center of gravity of a rod weighing 70 N is 250 cm from end “A”. If a force of 305 N acts downward at a position of 100 cm from end “A” and 300 cm from end “B”. The support at end “A” must exert an upward force of:
A) 125 N B) 250 N C) 255 N d. 275 N

14) 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?
A) the boy
B) the girl
C) both have the same non-zero centripetal acceleration.
D) both have zero centripetal acceleration.

15) 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?
A) 0.50 m/s
B) 1.0 m/s
C) 2.0 m/s
D) 4.0 m/s

16) 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?
A) 0.50 m/s^2 B) 1.0 m/s^2 C) 2.0 m/s^2 D) 4.0 m/s^2

17) After the manufacture of a car, the owner places oversized tires on the vehicle. How does this affect the speedometer compared to what the manufacturer intended?
A) reads to high B) reads to low C) breaks it D) reads normally

18) 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?
A) 0.95 rpm
B) 0.83 rpm
C) 0.075 rpm
D) 0.094 rpm

19) The units of angular momentum are:
A) N m B) kg m^2/s C) kg m^2/s^2 D) kg m^2

20) Angular velocity is best expressed in units of
A) meters per second. B) radians per second. C) omegas per second. D) arcs per second.

21) 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. Calculate the angular displacement of the bowling ball.
A) 111 rad B) 47.8 rad C) 1.11 rad D) 19.9 rad

22) 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. Calculate the angular velocity of the bowling ball..
A) 4.3 rad/s B) 5 rad/s C) 7.608 rad/s D) 48 rad/s

23) 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. Calculate the radial acceleration of the bowling ball.
A) 0.00 m/s^2 B) 0.215 rad/s^2 C) 5.31 rad/s^2 D) 205 m/s^2

24) 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. Calculate the tangential acceleration of the bowling ball.
A) 0.00 m/s^2 B) 0.215 rad/s^2 C) 5.31 rad/s^2 D) 205 m/s^2

25) 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?
A) 1.00 rad
B) 2.00 rad
C) 12.5 rad
D) 25.0 rad

26) 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?
A) 40
B) 20
C) 6.4
D) 3.2

27) 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?
A) the boy
B) the girl
C) Both have the same non-zero angular displacement.
D) Both have zero angular displacement.

28) 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?
A) the boy
B) the girl
C) Both have the same non-zero translational velocity.
D) Both have zero translational velocity.

29) 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?
A) 300 N
B) 150 N
C) 30 N
D) 15 N

30) 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?
A) 190 N
B) 380 N
C) 19 N
D) 38 N

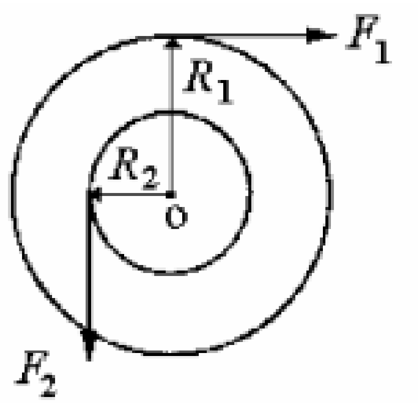


FIGURE 8-1

31) 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?

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

32) A sphere, disc, and hoop of equal mass and radius are released down an incline, at exactly the same instant. Which one reaches the bottom first?

A) sphere B) disc C) hoop D) it's a tie

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

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

34) 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?

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

35) The symbol for angular displacement is:

A) θ B) α C) ω D) t

End

CHAPTER / UNIT # __8__ **NAME: ___KEY________**
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FORM _Pre-Test______ **/70** **DATE: __________**

DIRECTIONS: Use the back side for any Bonus problems and be sure to identify the bonus area. The "Work Area" is to be used like scrap paper. If you need additional paper, raise your hand and I will provide you additional paper. Any extra scrap paper needs to be stapled to this answer sheet. GOOD LUCK!!

__B__	1.	__C__	26.
__C__	2.	__C__	27.
__B__	3.	__A__	28.
__C__	4.	__A__	29.
__D__	5.	__B__	30.
__B__	6.	__C__	31.
__D__	7.	__A__	32.
__A__	8.	__B__	33.
__A__	9.	__C__	34.
__B__	10.	__A__	35.
__C__	11.	_____	36.
__A__	12.	_____	37.
__C__	13.	_____	38.
__A__	14.	_____	39.
__C__	15.	_____	40.
__D__	16.	_____	41.
__B__	17.	_____	42.
__A__	18.	_____	43.
__B__	19.	_____	44.
__B__	20.	_____	45.
__A__	21.	_____	46.
__D__	22.	_____	47.
__D__	23.	_____	48.
__A__	24.	_____	49.
__D__	25	_____	50.

WORK AREA

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 "?".

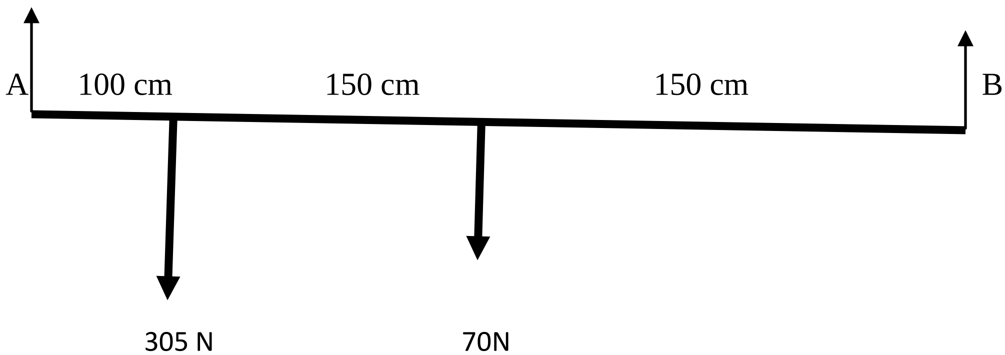
10. Inertia is always the resistance to changes in rotation and/or motion.

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

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 x 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: $V = \omega \bullet r$

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:

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

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

      $$a_r = V^2 / r = (4.3\text{m/s})^2 / 0.09\text{ m}$$

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
$\theta = ?$

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

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
$\theta = ?$

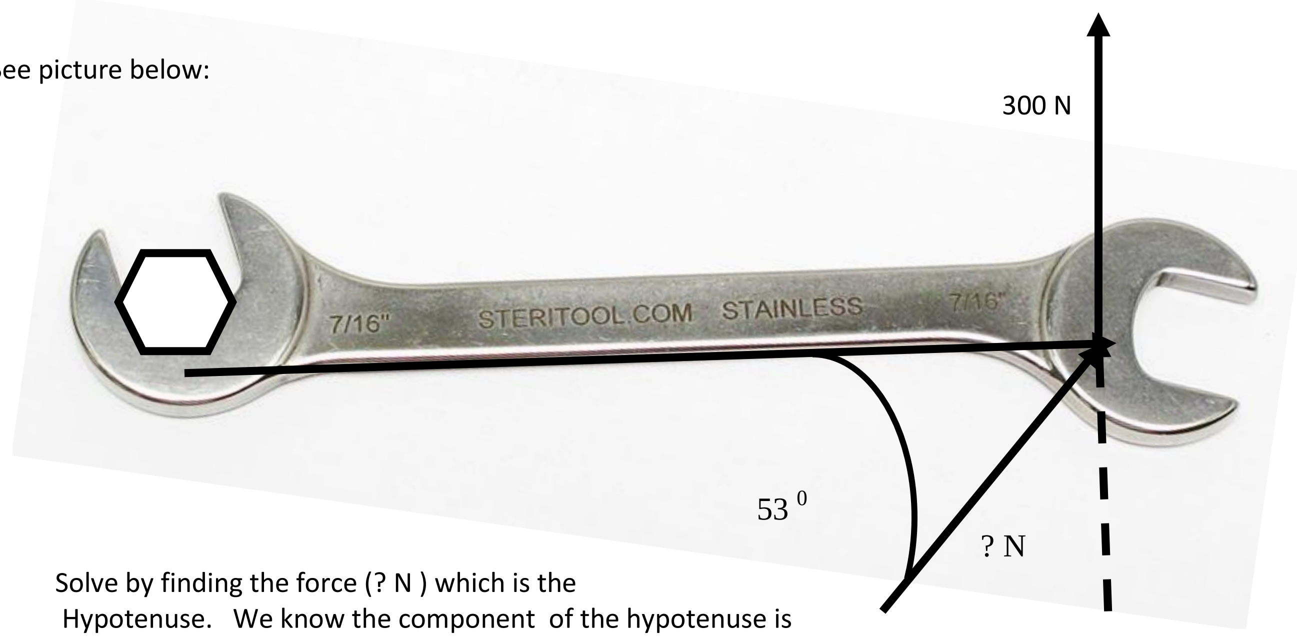
$$\omega_f^{\,2} = \omega_o^{\,2} + 2\alpha\theta$$

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= ½ 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?