Physics: *Rotational Mechanics HW*

Name: _____
Hour: ____ Date: _____

Set 1: Angular Momentum

1. An inflated volleyball of diameter 28 cm has a mass of 0.635 kg. If it spins at 15 rad/s, find the volleyball's angular momentum.

G:

U: S:

E: S:

2. A neutron star with radius 15 km and mass 2.8×10^{30} kg rotates at a rate of 324 rpm. Find the angular momentum of the star.

G:

U: S:

E: S:

3. A 6.00 m steel beam of mass 360. kg rotates about its center. If a 76.0 kg man stands on one end and the beam-man system rotates once around in 9.60 s, find the system's angular momentum.

Set 2: Conservation of Angular Momentum

4. An ice skater of mass 48 kg rotates at 7.3 rad/s when her arms are extended and her moment of inertia is 3.5 kg-m^2. After bringing her arms in, she rotates at 21.5 rad/s. Find her final moment of inertia.

G:

U: S:

E: S:

5. A 2.00 kg bike wheel of radius 0.300 m spins at 25.0 rad/s when a 0.300 kg reflector is 0.150 m from the axle. Find the angular speed if the reflector slides to a point 0.250 m from the axle.

ANSWERS: 1. 0.12 kg-m^2/s 2. 8.6×10^{39} kg-m^2/s 3. 1150 kg-m^2/s 4. 1.2 kg-m^2 5. 23.5 rad/s

6. A solid 10.0 kg cylinder of radius 1.00 m rotates at 7.00 rad/s about its axis. If a 0.250 kg piece of putty is dropped onto the rotating disk at a point 0.900 m from the axis, find the new angular speed of the system.

7. A 25 kg, solid-disk merry-go-round of radius 2.0 m rotates at 0.20 rev/s with an 80.0 kg man at the outer edge. If the man walks to a point 1.0 m from the center, find the new angular speed of the system.

Set 3: Rotational Kinetic Energy

8. Calculate the KE_{rot} of the volleyball mentioned in Problem 1.

G:

U: S:

E: S:

9. Calculate the KE_{rot} of the neutron star mentioned in Problem 2.

G:

U: S:

E: S:

10. Calculate the KE_{rot} of the beam-man system mentioned in Problem 3.

Set 4: Torque

11. Find the magnitude of the torque produced by a 3.0 N force applied to a door at a perpendicular distance of 0.25 m from the hinge.

G:

U: S:

E: S:

ANSWERS:

6. 6.73 rad/s
7. 3.6 rad/s (0.57 rev/s)
8. 0.93 J
9. 1.5×10^{41} J
10. 378 J
11. 0.75 N-m
12. 133 N

12. If the torque required to loosen a nut on the wheel of a car has a magnitude of 40.0 N-m, what minimum force must be exerted by a mechanic at the end of a 30.0 cm wrench in order to loosen the nut?

13. A simple pendulum consists of a 3.0 kg mass hanging at the end of a 2.0 m long light string that is connected to a pivot point. Calculate the magnitude of the torque (due to gravitational force) around this pivot point when the string makes a…

a. 5.0^{o} angle with the vertical

b. 15.0^{o} angle with the vertical

Set 5: Newton's 2nd Law for Rotation

14. A 100.0 kg potter's wheel of radius 0.50 m rotates at 50.0 rpm. The potter stops the wheel in 6.0 s by pressing a wet rag against the rim and exerting a radially-inward force of 70.0 N.

a. What is the magnitude of the wheel's angular acceleration?

b. What magnitude of torque is applied to the wheel?

15. A bicycle tire of radius 0.33 m and mass 1.5 kg is rotating at 98.7 rad/s. A torque of what magnitude is needed to stop the tire in 2.0 s?

16. A light string 4.00 m long is wrapped around a solid cylindrical spool with a radius of 7.5 cm and a mass of 0.500 kg. A 5.00 kg mass is then attached to the free end of the string, causing the string to unwind from the spool. Find the angular acceleration of the spool.

ANSWERS:

13a. 5.1 N-m
13b. 15 N-m

14a. 0.87 rad/s^2
14b. 11 N-m

15. 8.1 N-m
16. 2.6×10^3 rad/s^2

Set 6: Rotational Equilibrium

17. A 700.0 N window washer stands on a 3.00 m, 200.0 N uniform scaffold supported by vertical ropes at each end. Find the tension in each rope when the window washer stands 1.00 m from the left end of the scaffold.

18. A 3.2-m long beam is supported at its ends. On top of the beam, there are masses of 2.5 kg, 4.8 kg, and 3.1 kg, which are 1.1 m, 1.9 m, and 2.8 m (respectively) from the left end of the beam. Assuming the system is on Earth and that the weight of the beam is negligible, determine the left and right support reactions, at the ends of the beam.

19. A 400.0 N child sits on the left end and a 300.0 N child sits on the right end of a 2.00 m seesaw of negligible mass.

    a. Where should the pivot be placed to ensure rotational equilibrium?

    b. With the pivot placed as you found in Q19a…If a 225 N child sits 0.200 m from the 400.0 N child, where must a 325 N child sit to maintain equilibrium? (The 300.0 N child is still there, too, so there are now four children on the seesaw.)

20. A symmetric bridge 20.0 m long and weighing 4.00×10^5 N is supported by two piers located 3.00 m from each end. If a 1.96×10^4 N car is parked 8.00 m from the left end of the bridge, how much force does each pier exert?

ANSWERS:
17. $T_L = 667$ N, $T_R = 333$ N
18. $R_L = 39$ N, $R_R = 63$ N
19a. 0.857 m away from the 400 N child
19b. 0.455 m to the right of the pivot
20. $R_L = 2.13 \times 10^5$ N, $R_R = 2.07 \times 10^5$ N