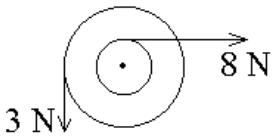
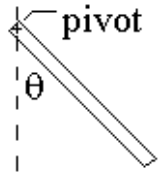
PHYSICS 2210 - PRACTICE EXAM #3

1. A solid cylinder is pivoted about a frictionless axle as shown. A rope wrapped around the outer radius of 2 m exerts a downward force of 3 N. A rope wrapped around the inner radius of 0.7 m exerts a force of 8 N to the right. The moment of inertia of the cylinder is 8 kg m^2. Find the angular acceleration.



2. If the cylinder in problem 1 is initially at rest, how long will it take for the cylinder to turn one revolution?

3. A uniform rod of mass *M* and length *L* is free to rotate about a pivot at the left end. It is released from rest in the horizontal position ($\theta = 90°$). What is the torque on the rod when it makes an angle θ with the vertical?

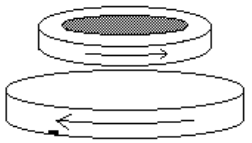


4. In problem 3, what is the downward linear acceleration of the right end of the rod when it is first released (at $\theta = 90^\circ$)?

5. Find the kinetic energy of a solid sphere of mass 0.5 kg and radius 10 cm that rolls without slipping on level ground at 12 m/s.

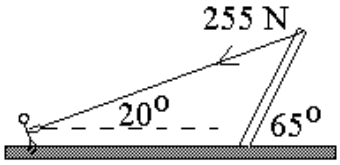
6. If the sphere in problem 5 rolls up a hill, how far above the ground will the sphere climb before it rolls back down?

7. A solid disk of radius 5 m and mass 8 kg rotates clockwise at 1.5 rad/s. Above this disk is a hoop of radius 2.5 m and mass 8 kg, rotating counterclockwise at 3 rad/s. The hoop drops down onto the disk, and friction causes them to rotate together. Find the final angular velocity.



8. In problem 7, find the kinetic energy lost in this collision.

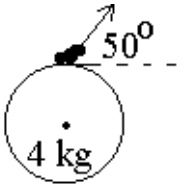
9. A man tries to raise a 75 kg flagpole that is attached to the ground by a frictionless pivot. The pole is 6 m long. The man pulls on a rope attached to the top of the pole with a force of 255 N. Find the net torque on the flagpole.



10. Find the angular acceleration of the flagpole in problem 9.

11. The man in problem 9 changes his force so the pole is at rest in static equilibrium. Find the tension in the rope, and the horizontal and vertical forces at the flagpole's pivot.

12. A 1.5 kg frog sits at rest on top of a solid disk. The disk's mass is 4 kg, its radius is 1.25 m, and it rotates on a frictionless axle. The frog jumps from the disk at 3.7 m/s at an angle of 50°. Find the angular momentum of the frog about the axle as it leaves the disk.



13. How much time will it take the disk in problem 12 to rotate one complete revolution after the frog jumps?

14. A sailor on a lake uses a rope to lower an iron ball of radius 30 cm to a depth of 80 m below the surface of the water. What is the pressure (in atm) at that depth? The density of water is 1000 kg/m^3.

15. Find the tension in the rope in the previous problem. The density of iron is 7.86 x 10^3 kg/m^3.

16. A hollow steel ball has a radius of 1.5 m and a mass of 15 kg. Inside the ball is a vacuum. The ball is anchored to the ground by a cord. Find the tension in the cord. The density of air is 1.29 kg/m^3.

17. Water flows through a horizontal pipe. At position 1 (the wide end of the pipe) the pressure is 3 x 10^5 Pa and the water speed is 12 m/s. At position 2 (the narrow end), the pressure is 1.3 x 10^5 Pa. What is the water speed at position 2?

18. The diameter of the pipe in problem 14 is 65 cm at position 1. What is the diameter of the pipe at position 2?

19. The water from the pipe in problem 19 flows into a tank of volume 180 m^3. If the tank is initially empty, how long will it take to fill the tank?

20. A satellite has a mass of 100 kg and is at an altitude of 2 x 10^6 m above the ground. What is the potential energy of the satellite-Earth system?

21. In problem 20, what is the force of gravity on the satellite?

22. A white dwarf is a compact star. Its mass is equal to that of the Sun, but its radius is that of Earth. Find the acceleration due to gravity at a white dwarf's surface.

23. An apple is dropped from a height of 12.8 x 10^6 m above the surface of the white dwarf described in problem 22. With what speed does the apple strike the surface of the white dwarf?

24. What is the minimum energy needed to send a 3000 kg spacecraft from Earth to an infinitely distant point in space?

25. A neutron star is very compact. If the escape velocity of a neutron star with the same mass as the Sun is 1.5 x 10^8 m/s (half the speed of light), what is the radius of the neutron star?

26. When a mass is attached to the end of a vertical spring, the spring is stretched down 3 cm. If the mass is pulled down a bit farther and then released, what is the period of oscillation of the mass on the spring?

27. In problem 26, if the mass moves through its equilibrium position at 50 cm/s, what is the amplitude of the oscillation?

28. On Mars, a pendulum of length 2.36 m swings back and forth once in 5 seconds. What is the acceleration due to gravity on Mars?

29. A Christmas tree ball hangs from a hook in the ceiling. If the radius of the ball is 8 cm, find the period of the ball's oscillation as it swings on the hook.

Answers: (1) 0.05 rad/s^2 (2) 15.9 sec (3) $-(Lmg \sin \theta)/2$ (4) -14.7 m/s^2 (5) 50.4 J (6) 10.3 m (7) 0 (8) 338 J (9) 150 N m (10) 0.167 rad/s^2, counterclockwise (11) T = 220 N, F_h = 206 N, F_v = 810 N (12) -4.46 kg m^2/s, clockwise (13) 4.40 s (14) 8.74 atm (15) 7600 N (16) 31.7 N (17) 22 m/s (18) 48 cm (19) 45.2 s (20) -4.77 x 10^9 J (21) 569 N (22) 3.29 x 10^6 m/s^2 (23) 5.28 x 10^6 m/s (24) 1.88 x 10^{11} J (25) 11.9 km (26) 0.348 s (27) 2.77 cm (28) 3.73 m/s^2 (29) 0.733 s