Physics 200 Sample Exam Three
December 1, 2017

1. A small rocky planet has a mass of 1020 kg and a radius of 5050 km. A 56.7 kg rock is dropped from rest from a distance of 91800 km from the center of the planet. With what speed does it strike the surface of the planet?

2. A small planet orbits a distant star in a circluar orbit. The planet is observed to have a period of 132 days and the star does not move (thus it is far more massive then the planet). The distance from the center of the star to the planet is observed to be 2.31×10^{13} m. What can you say about the mass of the star? What about the mass of the planet? (Note: there are 86400 seconds in a day).

3. A 1.23 m long uniform beam, mass 2.34 kg, is held horizontally, and released. The left edge is pinned to the wall, so it rotates about that point. Find the initial angular acceleration of the beam, just after it is released.

4. A 5.5 cm radius disk speeds up from rest to a final rotational speed of 22.2 radians/second over the course of 5.5 revolutions. Assuming the angular acceleration is constant, find: α and the time this process takes.

5. A thin disk, mass m_d, radius r_d, is rotating about its center of mass at initial angular speed ω_0 when a thin rod is dropped onto it from above, as pictured below, so that the center of the rod, length L, mass m_r, is a distance x from the center of the disk. Find the final angular speed of the disk/rod system assuming the system continues to rotate about the center of the disk. Given the moment of inertia of the disk is $I = \frac{1}{2}mr^2$, and the moment of inertia of a thin rod about its center of mass is $I = \frac{1}{12}mL^2$.

6. A pulley is made of a uniform thin disk, radius r, mass m_1, from which a single mass hangs on the right hand side: mass m_2. Find the acceleration of the mass and the angular acceleration of the pulley in terms of: r, m_1, m_2. Given the moment of inertia of the disk is $I = \frac{1}{2}mr^2$.

7. A 4.56 m long uniform diving board, mass 12.3 kg, is bolted to the ground via two bolts, one at the far left, one bolt 0.76 m from the left. When a 45 kg person stands on the right edge of the diving board, what are the forces acting upon each bolt? Direction?

8. A 1 cm diameter bubble of air forms in water, density 1000 kg/m^3. Find its upward acceleration. The weight of the air is negligable.

9. When you suck on a straw, you reduce the air pressure in the straw, allowing the fluid to rise up. How high can water rise in a straw, if atop the straw is a vacuum pump which reduces the air pressure to zero? Does this change if the fluid changes?

10. The motion of a vibrating wing is found to obey the equation $y(t) = 0.15\sin(134t)$. Where y is measured in milimeters, and t in seconds. Find the period of motion, frequency, and how far does the wing travel from highest to lowest position?

11. A 22.2 kg box is hooked to a vertical, unknown spring, and it oscillates 10 times over the course of 12.34 seconds. Find the spring constant of the spring.