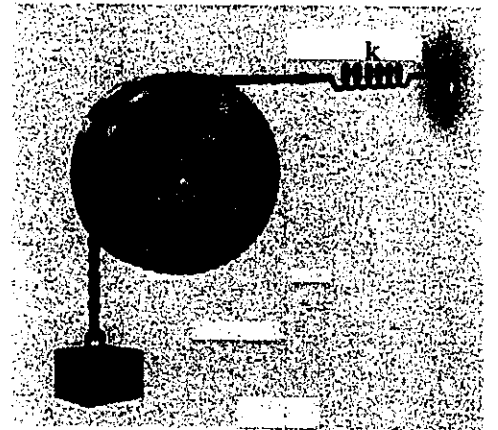


1. (25%) A block of mass m is suspended from a cord wrapped around a disk of radius r and mass M , as shown in the right figure. Let the stiffness of the spring be k .
- (i) Write down the kinetic energy of the system. (8%)
 - (ii) Give the potential energy of the system. (8%)
 - (iii) Determine the natural period of vibration for the system. (9%)



2. (25%) A water jet, having a velocity of V_w and the diameter of a , impinges upon a single moving blade. The blade moves with a constant velocity of V_b away from the jet, and water has a density of ρ .
- (i) Please determine the horizontal and vertical components of force which the blade is exerting on the water. (20%)
 - (ii) What power does the water generate on the blade? (5%)



3. (25 %) A rocket ejects mass backward with a constant speed $u=3000$ m/s relative to the rocket. If the initial mass of the rocket is $m_0=7.39 \times 10^6$ kg, what is the change in the rocket's speed at a later time when the mass is $m=10^6$ kg? In this problem, we assume that the rocket moves under the influence of no external forces.

4. (25%) A uniform stick of mass $m=1.2$ kg and length $\ell=2.4$ m is placed on a frictionless horizontal surface (thus you can ignore gravity in this problem). It is pivoted at a point a distance s from its center O , as illustrated in the figure. A fully relaxed spring with spring constant $k=4.8$ N/m is attached to the far end of the stick, perpendicular to the stick. If the stick is imposed by a tiny kick, what value of s yields the largest frequency of small oscillations, and what is the largest frequency ω_{max} ?

