1. Consider a pendulum of length b and a bob of mass m at its end (Figure 1) moving through oil. The massive bob undergoes small oscillations, but the oil retards the bob's motion with a resistive force proportional to the speed $F_{res} = 2m\sqrt{gb}\dot{\theta}$. The bob is initially pulled back at $t = 0$ with $\theta = \alpha$ and $\dot{\theta} = 0$. Find the angular displacement θ as a function of time t. (20%)

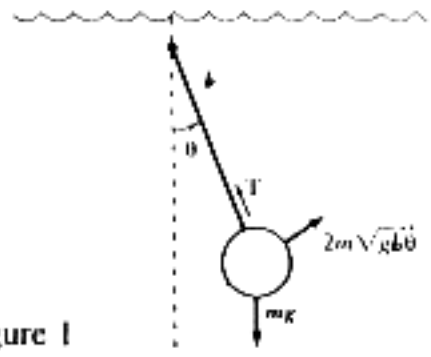

Figure 1

2. Consider a thin disk of mass M and radius a. Find the gravitational force on a mass m located along the axis of the disk (Figure 2) (20%)

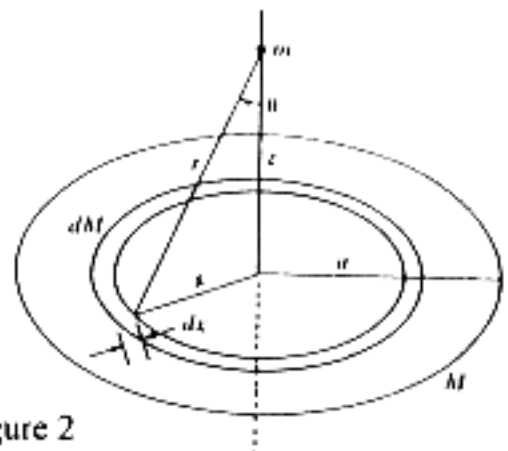

Figure 2

3. The point of support of a simple pendulum of length b moves on a massless rim of radius a rotating with constant angular speed ω. Obtain the angular acceleration for the angle θ shown in Figure 3. (20%)

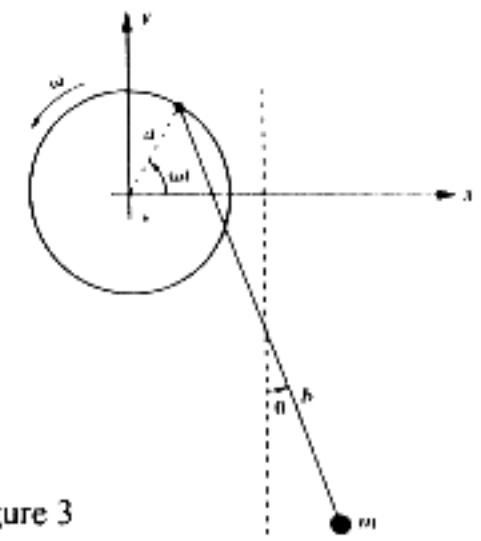

Figure 3

4. Consider a rope of mass per unit length ρ and length a suspended just above a table as shown in Figure 4. If the rope is released from rest at the top, find the force on the table when a length x of the rope has dropped to the table. (20%)

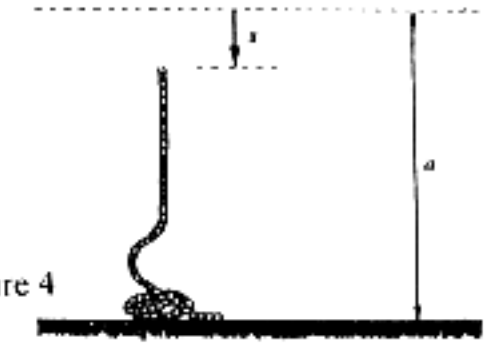

Figure 4

5. Two point masses, m_1 and m_2, are connected by a weightless shaft of length $2b$ forming a dumbbell. The dumbbell is constrained to rotate with a constant angular velocity $\vec{\omega}$ about an axis that makes an angle α with the shaft and passes through the center of the shaft. Find the torque required to maintain the motion shown in Figure 5. (20%)

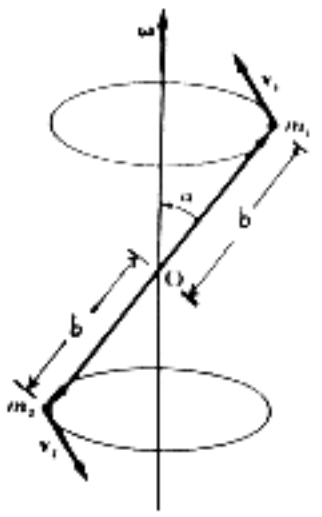

Figure 5

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