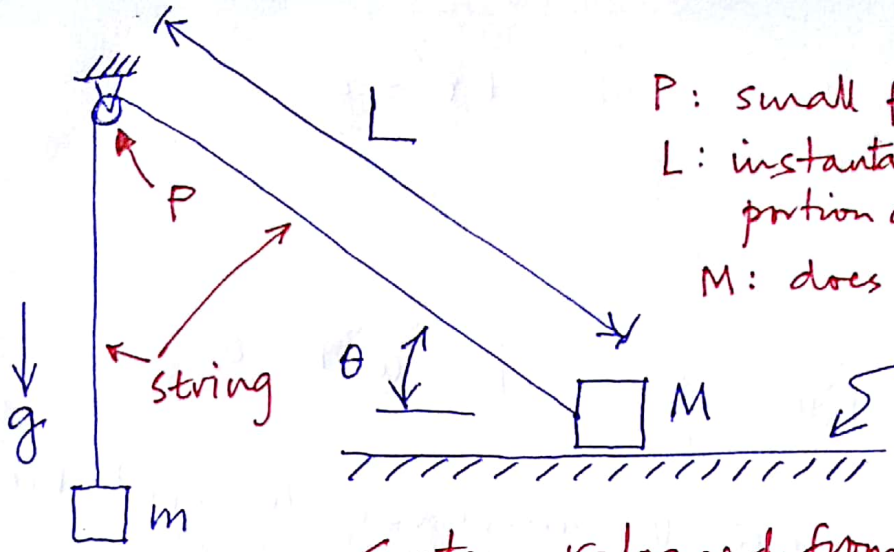
①



P: small frictionless ~~string~~ pulley

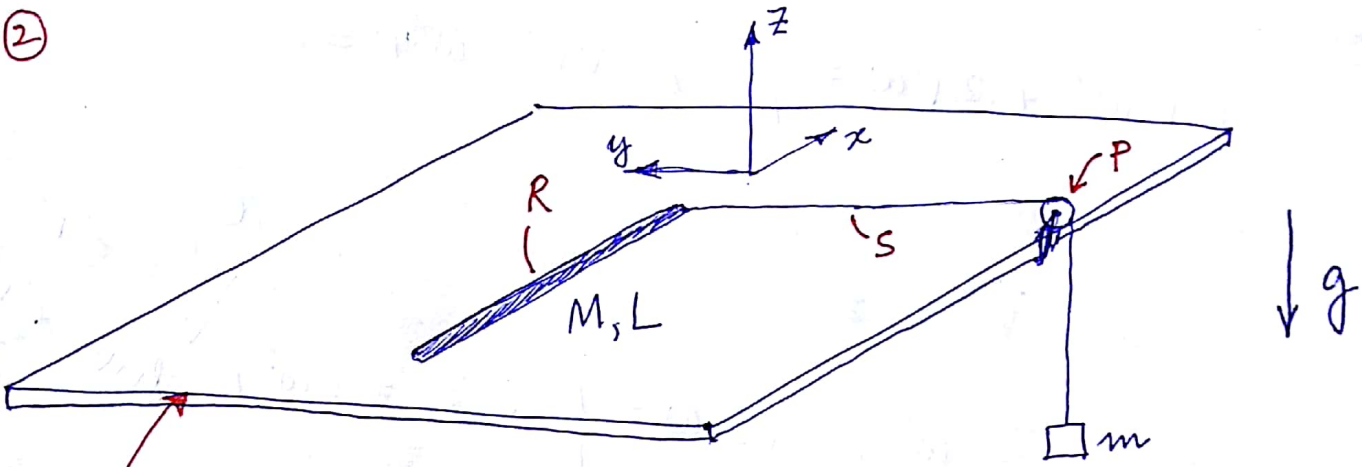
L: instantaneous length of slanted portion of string

M: does not lift up

System released from rest.
Immediately afterwards, what is the tension in the string?

---

②



T: Horizontal frictionless table, P: small frictionless pulley

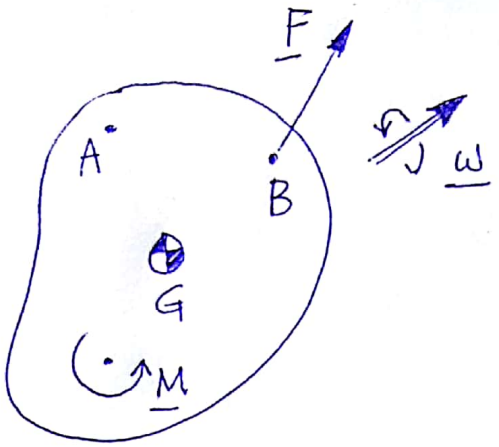
z-axis is perpendicular

S: string portion is horizontal & parallel to y-axis

R: uniform thin rod of length L, lying parallel to x-axis, mass M.

System released from rest. Immediately afterward, find the tension in the string.

(3)



A rigid body has mass m (given), can located at G (given), and at some instant the velocity $\underline{v}_G$ and angular velocity $\underline{\omega}$ (absolute quantities) are given. $\underline{v}_{GB}$ and $\underline{v}_{GA}$ at that instant are given as well. A given vector moment $\underline{M}$ acts on the body, and a given force $\underline{F}$ acts at B.

What is the acceleration of point A?

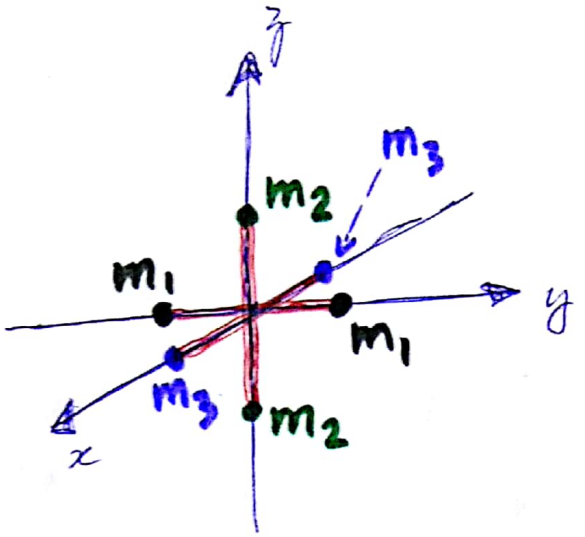
(4) A rigid body is rotated through an angle of 42 degrees about an axis along the unit vector $0.1817\,\hat{i} + 0.6198\,\hat{j} - 0.7634\,\hat{k}$. Find the rotation matrix R.

(5) The rotation matrix R for a body is

$$\begin{bmatrix} 0.4048 & 0.7959 & 0.4501 \\ -0.1721 & -0.4171 & 0.8924 \\ 0.8980 & -0.4388 & -0.0319 \end{bmatrix}.$$

Find a unit vector that is unchanged by this rotation.

(6)



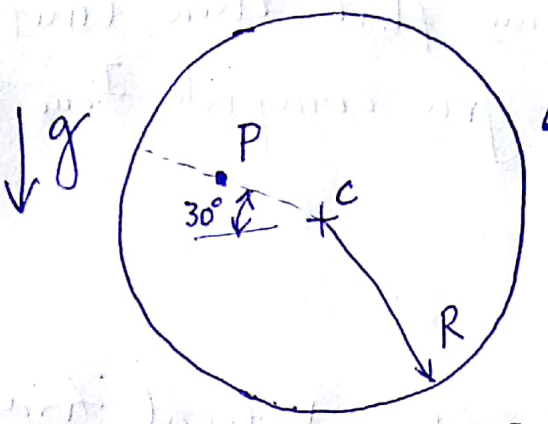
Three massless, thin, rigid rods of length 2 m each are joined at their centre as shown. 3 pairs of point masses, of mass m_1, m_2 and m_3, are attached to the ends of the rods as shown. The resulting rigid body has

$$I_{cm} = \begin{bmatrix} 3 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 5 \end{bmatrix} \text{ in SI units.}$$

Find the masses m_1, m_2 and m_3.

(7) Two unit vectors $\hat{n}_1$ and $\hat{n}_2$ are given (not perpendicular to each other). One thin rigid uniform rod of mass m_1 and length L_1 is parallel to $\hat{n}_1$, and another rod of mass m_2 and length L_2 is parallel to $\hat{n}_2$, and these rods are joined to each other at their center. Given the components of $\hat{n}_1$ & $\hat{n}_2$ in some xyz coordinate system, compute I_{cm} of the composite (two-rod) rigid object.

(8)



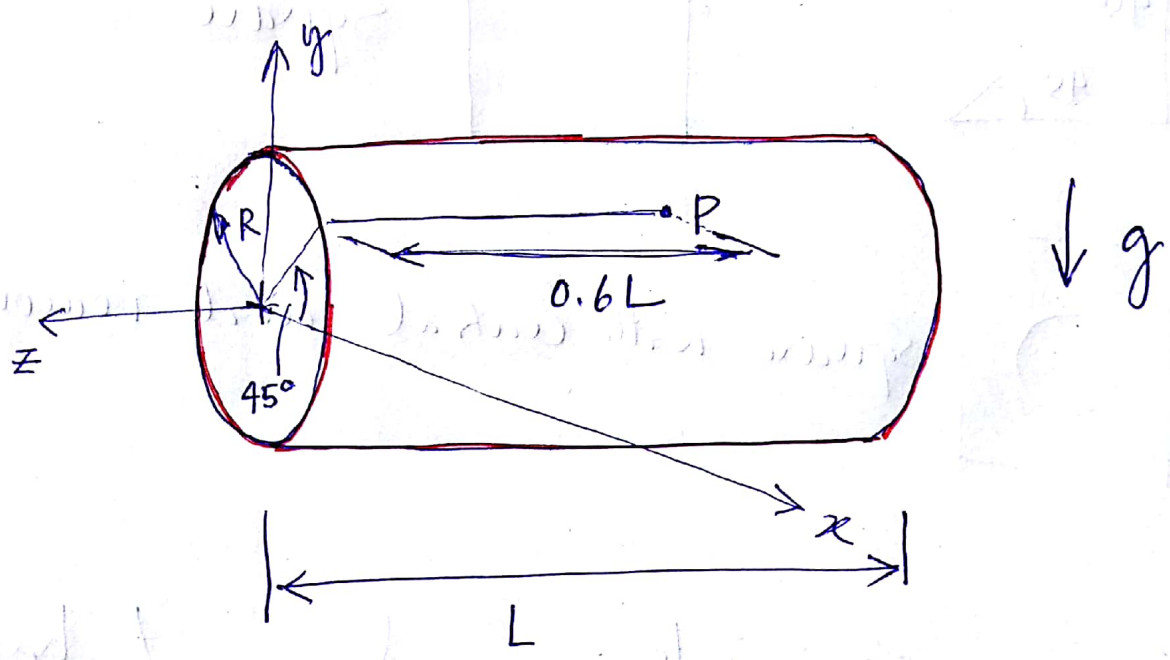
uniform disk, m, R

Hinged frictionlessly at P, released from rest.

Distance PC = 0.6 R.

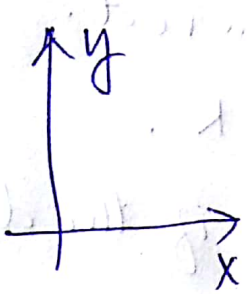
Find the angular acceleration of the disk upon release.

(9)

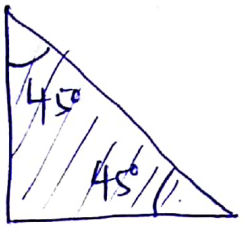


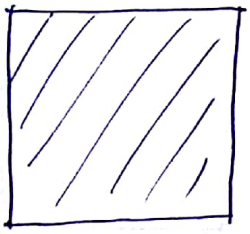
Uniform rigid cylinder of mass m, radius R and length L. Restrained by a frictionless ball and socket joint at P, located 0.6L down the length and at 45° above the horizontal midplane at the configuration shown. Released from rest. Find the initial angular acceleration, immediately upon release.

(10) Consider the following flat, thin, uniform, rigid bodies. Can you compute I_{cm} for each one?

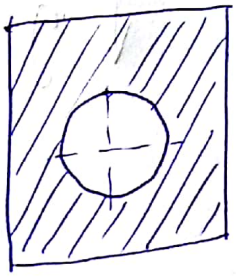


(Equilateral triangle)

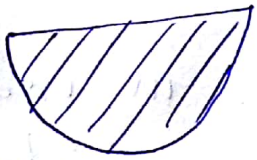




Square



Square with central circle removed



Semicircle (half disk)

half circle (wire)