INFOMGP - GAME PHYSICS

EXERCISES LECTURE 4

EXERCISE 4.1

Calculate or determine the mass and the center of mass for the following objects.

i. A box with size (40 cm, 80 cm, 50 cm) centered at (-20 cm, 40 cm, 20 cm) with uniform density of 1400 kg/m^3.

ii. A cylinder shell with inner radius 1 meter and outer radius 2 meters, aligned along the x-axis with length 40 cm and its center at (20 cm, 20 cm, 20 cm) with uniform density of 300 kg/m^3.

iii. The composite object consisting of the two objects above (i. and ii.).

EXERCISE 4.2

Show that the moment of inertia in the z-direction I_{zz} for a box with mass m and dimensions (w, h, d) is given by $I_{zz} = \frac{1}{12}m(w^2 + h^2)$.

EXERCISE 4.3

Show that the moment of inertia in the z-direction I_{zz} for a cylinder oriented along the z-axis with mass m and radius r is given by $I_{zz} = \frac{1}{2}mr^2$.

EXERCISE 4.4

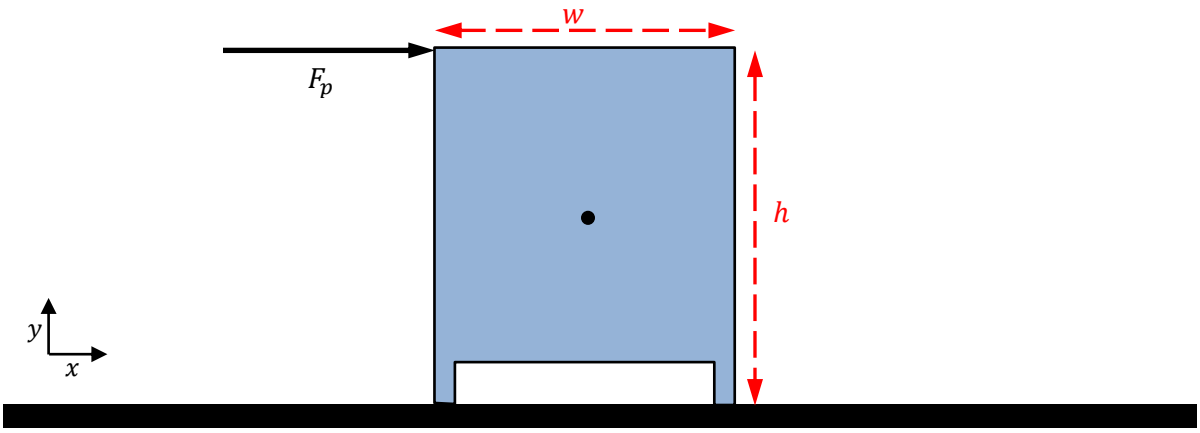
Calculate the moment of inertia along the x-axis I_{xx} for the three objects of exercise 4.1. Please note that the moment of inertia of a cylinder shell along the x-axis is given by $I_{xx} = \frac{1}{2}m({r_1}^2 + {r_2}^2)$.

EXERCISE 4.5

Given a ring with radius R of n cylinders, each having a mass of M/n, and a radius r ($\ll R$). Determine the I_{zz} for the entire system of n cylinders. Remember that I_{zz} for a cylinder is $\frac{1}{2}mr^2$. What happens if n becomes larger and larger?

EXERCISE 4.6

Analyze the forces and torques on the box. What force F_p is necessary to tip the box over?



EXERCISE 4.7

Analyze the forces and torques on the rolling cylinder of radius r. What is its linear acceleration?