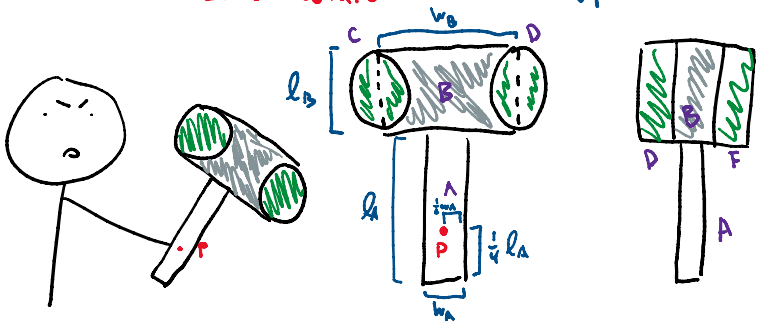
20-R-KIN-DK-7

Intermediate Radius of Gyration Video



Another kid constructs his own foam hammer to overthrow the previous foam hammer tyrant. The head of the hammer consists of a rectangular plate and four circular disks. The handle is a lone rectangular plate. If point P acts as a pin in which the hammer rotates, what is the hammer's radius of gyration about point P? The density of the foam is ***rho = 120 kg/m^3***. Assume that the foam acts as a rigid body and the hammer is undergoing planar motion.
Plate A has a length ***l_A = 40 cm*** and a width ***w_A = 6 cm***. Point P is located on plate A, a distance of d_y = 1/4 l_A from the bottom and d_x = ½ w_A from the side.
Plate B has a length ***l_B = 22 cm*** and a width ***w_B = 25 cm***.
Plate C is identical to plates D, E, and F, and have a diameter equivalent to l_B.
Plate A, C, D, E, and F have a thickness of ***t = 4mm*** while plate B has a thickness of ***t = 5mm***.

A: Thin Plate: $I_{zz} = \frac{1}{12}m(a^2+b^2)$

G is in the middle of A

$x = 3cm \quad y = 20cm$

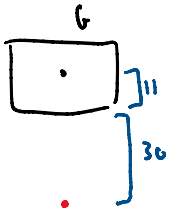
$d = 20cm - 10cm = 10cm$

$m = \rho V = 120(0.4 \times 0.06 \times 0.004) = 0.01152\ kg$

$I_{PA} = I_{zz} + md^2 = \frac{1}{12}(0.01152)(0.4^2+0.06^2) + 0.01152(0.1)^2$

$= 0.000272256\ kgm^2$

B:



Thin plate $d = 11cm + 30cm = 41cm$

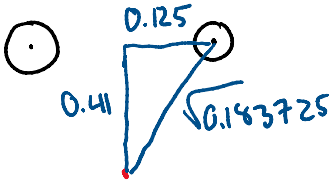
$m = \rho V = 120(0.25 \times 0.22 \times 0.005)$

$= 0.033\ kg$

$I_{PB} = I_{zz} + md^2 = \frac{1}{12}(0.033)(0.25^2+0.22^2) + 0.033(0.41)^2$

$= 0.005652275$

C, D, E, F 4 thin circular disks $I_{zz} = \frac{1}{2}mr^2$



$m = \rho V = 120(\pi(0.11)^2 \times 0.004)$

$= 0.01824637$

$I_{PC} = I_{zz} + md^2 = \frac{1}{2}(0.01824637)(0.11)^2 + (0.01824637)(0.183725)$

$= 0.003462704$

$I = I_{PA} + I_{PB} + 4I_{PC} = 0.01947535$

$m = m_A + m_B + 4m_C = 0.11750548$

$k_p = \sqrt{\frac{I_p}{m}} = \sqrt{\frac{0.01947535}{0.11750548}} = \boxed{0.41230456}$