Chapter 12 -Static Equilibrium and Elasticity

Note Title 7/1/2005

1. Since in equilibrium, force upward on bat by player must equal in magnitude the force of gravity. $\therefore$ Force = 10 N upward.

Total torque must also be 0. Torque of gravity is $(10\ N)(0.6\ m) = 6.0\ N\text{-}m$ (clockwise).
$\therefore$ Torque by player on bat $= 6.0\ N\text{-}m$ counterclockwise.

8. Break up to track into small subsections of length Δx. Assume uniform density. This will cancel in the equation:

$$\frac{\mu \Delta V_1 x_1 + \mu \Delta V x_2 + \cdots + \mu \Delta V x_n}{\mu \Delta V_1 + \mu \Delta V_2 + \cdots + \mu \Delta V_n}$$

Where ΔV_i = the volume of a subsection.

$\Delta V_i = (\Delta x_i)(0.05) f(p_i)$, where p_i is a point in the interval of Δx_i, and $f(x) = \frac{(x-3)^2}{9}$

$\therefore$ As $\Delta x_i \to 0$, $\sum_{i=1}^{n} (\Delta x_i)(0.05) f(p_i)$ = volume of

$$\text{track} = \int_0^3 (0.05)\frac{(x-3)^2}{9}\,dx = (0.05)\frac{(x-3)^3}{27}\Bigg|_0^3 =$$

$$0 - (0.05)\frac{(-27)}{27} = 0.05 \text{ meters}^3$$

For the numerator, $\int_0^3 (0.05)\frac{(x-3)^2}{9} x \, dx =$

$$\frac{0.05}{9}\int_0^3 (x^3 - 6x^2 + 9x)\, dx =$$

$$\frac{0.05}{9}\left(\frac{x^4}{4} - 2x^3 + \frac{9}{2}x^2\right)\Big|_0^3 =$$

$$\frac{0.05}{9}\left(\frac{81}{4} - 54 + \frac{81}{2}\right) = \frac{0.05}{9}(6.75) = 0.0375$$

$$\therefore \text{C.G.} = \frac{0.0375}{0.05} = \underline{0.75\text{ m}}$$

15. (a) Let f_x = friction force, f_n = normal force at point of contact.

Let N = force of nail on hammer
(By Newton's 3rd law = − force hammer on nail)

$\therefore N_x = 150 + f_x$, $N_y = f_n$

From torques, $(150\text{ N})(30.0\text{ cm}) = (N_y)(5.00\text{ cm})$

$\therefore N_y = 900\text{ N}$

$N \cos 30^\circ = N_y$,

$N = \dfrac{900}{\cos 30^\circ} = \underline{\underline{1.04 \times 10^3 N}}$, directed 60° from horiz (counterclockwise)

(b) $N_x = N \sin 30^\circ = 520 N$, $\therefore f_x = 520 - 150$
$= 370 N$

$\therefore$ from f_x and f_n,

$$\text{force} = (370 N)\hat{i} + (900 N)\hat{j}$$