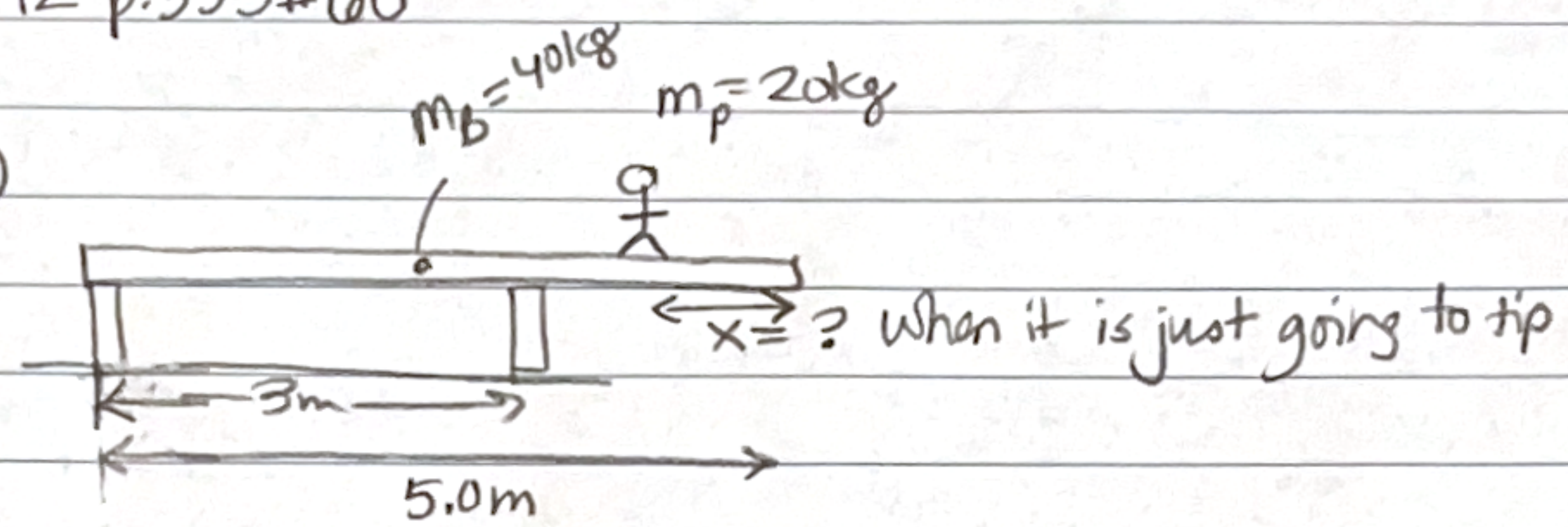
Ch 12 p.333 #60

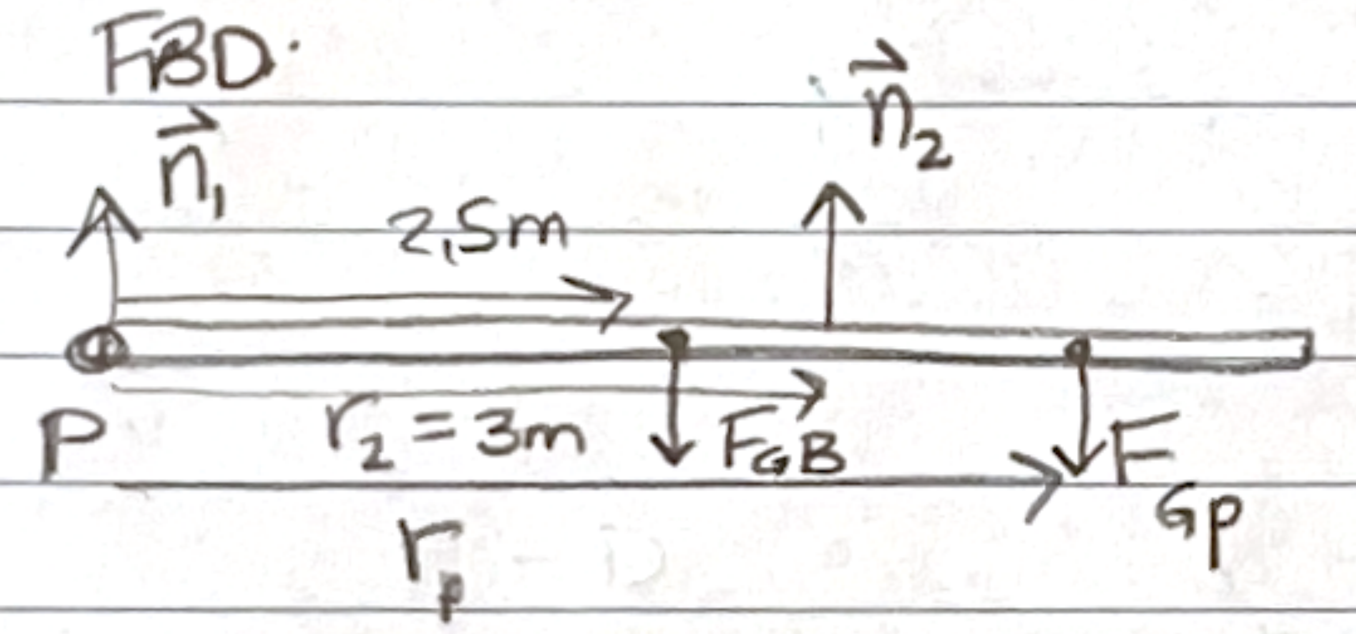
a)



b) system: Beam

models: rigid body, static equilibrium

FBD:



F_{GB} = force of gravity on beam
F_{Gp} = force of gravity on person
r_B = distance to c.m. of board
r_p = distance to person
r_2 = distance to n_2

(c) represent mathematically and (d) solve

$\Sigma F_x = 0$	$\Sigma F_y = 0$	$\Sigma \vec{\tau} = 0$
(no x-forces!)	$n_1 + n_2 - F_{GB} - F_{Gp} = 0$ at tipping point, $n_1 = 0$ because the beam would just be losing contact with that support, so $0 + n_2 - F_{GB} - F_{Gp} = 0$ $n_2 = F_{GB} + F_{Gp}$ $n_2 = (40kg)(9.8\frac{N}{kg}) + (20kg)(9.8\frac{N}{kg})$ $n_2 = 588N$	$r_2 n_2 - r_B F_{GB} - r_p F_{Gp} = 0$ $r_2 n_2 - r_B F_{GB} = r_p F_{Gp}$ $\frac{r_2 n_2 - r_B F_{GB}}{F_{Gp}} = r_p$ $r_p = \frac{r_2 n_2 - r_B m_B g}{m_p g}$ $r_p = \frac{(3m)(588N) - (2.5m)(40kg)(9.8 N/kg)}{(20kg)(9.8 N/kg)}$ $r_p = \frac{1764 - 980}{196}$ $r_p = 4m$ This from left end, so the distance from the right end is $\boxed{1m}$

e) Evaluate: 1m from the right end is reasonable because if n_1 isn't exerting a force, the beam is balanced on n_2. So relative to n_2, the ccw torque of F_{GB} equals the cw torque of F_{Gp}. Since the person has half the mass of the beam, he must be twice as far from the n_2 support, and $2(0.5m) = 1m$ from n_2, which is 1m from the end of the beam also.