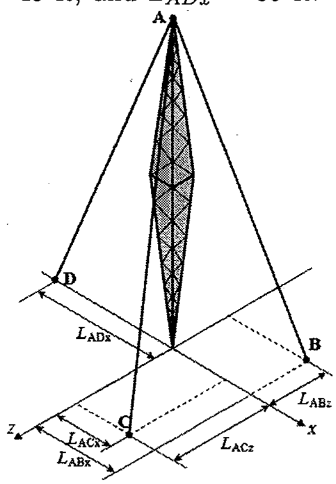
zzPogo, E

p313s12 — **Section 2**
Due Thr, Feb 9, 2012 at 21:01 — Set 13
Physics 313: Applied Mechanics — CAPA ID 2744

1. [10pt] A radio tower of height 110 ft and weight 3000 lbf is held by three wires, as shown. A strain gauge indicates that T_{AC} = 900 lbf. Given: L_{ABx} = 40 ft, L_{ABz} = 25 ft, L_{ACx} = 30 ft, L_{ACz} = 45 ft, and L_{ADx} = 35 ft. Determine T_{AB}.



2. [10pt] Determine T_{AD}.

3. [10pt] Determine the magnitude of the normal force exerted on the tower by the ground.

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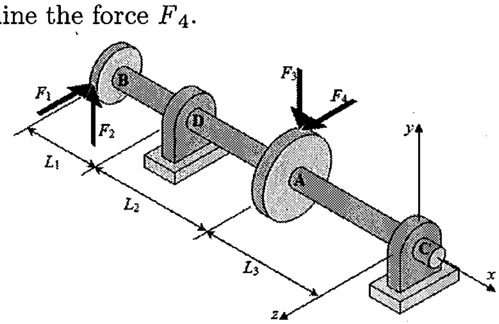
4. [4pt] The drive shaft shown rotates at constant speed. The shaft and wheels are massless. The forces on pulley A act directly at the top (i.e., at the maximum y position), and the forces on pulley B act at its front (i.e., at the maximum z position). Given: F_1 = 110 N, F_2 = 280 N, F_3 = 490 N, L_1 = 5 cm, L_2 = 8 cm, L_3 = 10 cm, R_A = 9 cm, and R_B = 17 cm. As always, all reactions are assumed positive if they act in the same direction as the coordinate axis.

Determine the force F_4.



5. [4pt] Determine the reaction R_{Cy}.

6. [4pt] Determine the reaction R_{Cz}.

7. [4pt] Determine the reaction R_{Dy}.

8. [4pt] Determine the reaction R_{Dz}.

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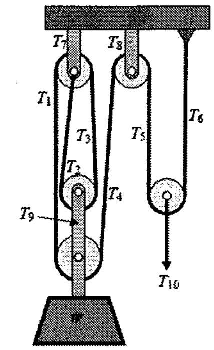
9. [5pt] A mechanic uses the pulley system shown (consisting of five pulleys, two cables, and three connecting links) to hold a W = 780 pound engine. The diameter of the pulleys is much less than the length of the cable between them, so you can assume that all the cable segments are vertical. Assume that the mass of each pulley, cable, and link is small compared to the engine. Determine the tensions T_1, T_7, and T_8.



10. [5pt] Determine the tensions T_2, T_6, and T_9.

11. [5pt] Determine the tensions T_3, T_5, and T_{10}.

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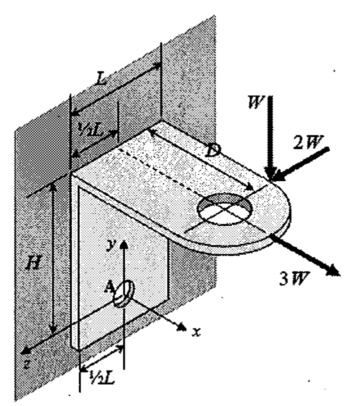
12. [5pt] A thin bracket mounted to a wall is subjected to the forces shown, where H = 7 cm, L = 5 cm, and D = 9 cm. The connection to the wall at A is weak; it will break if any of the reaction components there violate the following limits:

$|F_{Ax}| \le 2800$ N, $|M_{Ax}| \le 110$ N·m

$|F_{Ay}| \le 900$ N, $|M_{Ay}| \le 140$ N·m

$|F_{Az}| \le 1900$ N, $|M_{Az}| \le 280$ N·m

Probably, the connection will not break in all six ways at the same time. What is the smallest value of W that will violate the F_x restriction?



13. [5pt] What is the smallest value of W that will violate the F_y restriction?

14. [5pt] What is the smallest value of W that will violate the F_z restriction?

15. [5pt] What is the smallest value of W that will violate the M_x restriction?

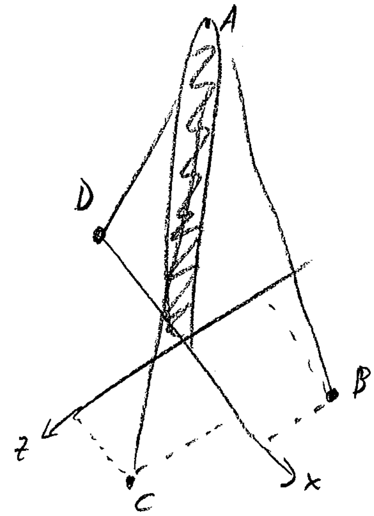
16. [5pt] What is the smallest value of W that will violate the M_y restriction?

17. [5pt] What is the smallest value of W that will violate the M_z restriction?

18. [5pt] What is the maximum value of W for this bracket?

Exam ①

① $W = 3000$ lb
$H = 110$ ft
$T_{AC} = 900$ lb



$L_{ABx} = 40$ ft	$L_{ACx} = 30$ ft	$L_{ADx} = 35$ ft
$L_{ABy} = 110$ ft	$L_{ACy} = 110$ ft	$L_{ADy} = 110$ ft
$L_{ABz} = 25$ ft	$L_{ACz} = 45$ ft	$L_{ADz} = 0$ ft
$L_{AB} = 119.7$ ft	$L_{AC} = 122.6$ ft	$L_{AD} = 115.4$ ft

$\Sigma F_z = 0 \rightarrow$ $T_{ACz} = T_{ABz}$

$T_{AC}\dfrac{L_{ACz}}{L_{AC}} = T_{AB}\dfrac{L_{ABz}}{L_{AB}} \rightarrow$ $T_{AB} = T_{AC}\dfrac{L_{AB}}{L_{ABz}} \cdot \dfrac{L_{ACz}}{L_{AC}}$

$\boxed{T_{AB} = 1582 \text{ lb}}$

② $\Sigma F_x = 0$

$T_{ACx} + T_{ABx} = T_{ADx}$

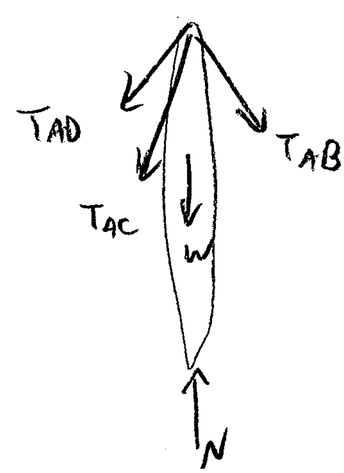
$T_{AD}\dfrac{L_{ADx}}{L_{AD}} = T_{AC}\dfrac{L_{ACx}}{L_{AC}} + T_{AB}\dfrac{L_{ABx}}{L_{AB}}$ $T_{AD} = \left(T_{AC}\dfrac{L_{ACx}}{L_{AC}} + T_{AB}\dfrac{L_{ABx}}{L_{AB}}\right)\left(\dfrac{L_{AD}}{L_{ADx}}\right)$

$\boxed{T_{AD} = 2470 \text{ lb}}$

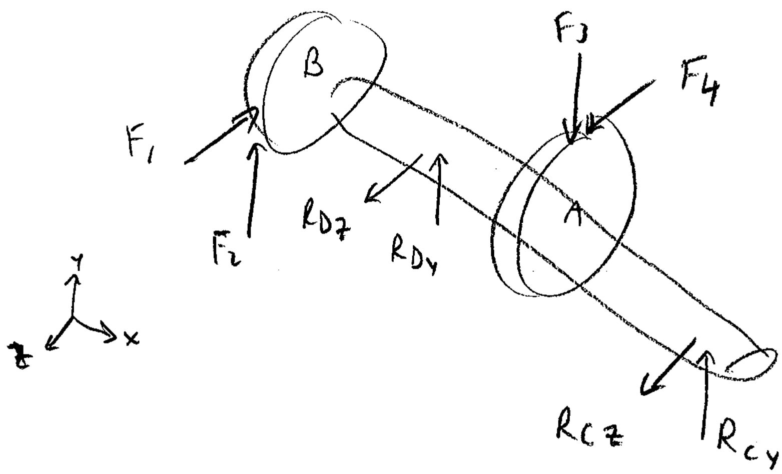
③ $N = W + T_{ADy} + T_{ABy} + T_{ACy}$

$N = W + T_{AD}\dfrac{L_{ADy}}{L_{AD}} + T_{AB}\dfrac{L_{ABy}}{L_{AB}} + T_{AC}\dfrac{L_{ACy}}{L_{AC}}$

$\boxed{N = 7615.2 \text{ lb}}$



(4) $F_1 = 110\,N$
$F_2 = 280\,N$
$F_3 = 490\,N$
$L_1 = 5\,cm$
$L_2 = 8\,cm$
$L_3 = 10\,cm$
$R_A = 9\,cm$
$R_B = 17\,cm$



(4) $\Sigma M_x = 0 = -R_B F_2 + R_A F_4 = 0$

$\boxed{F_4 = F_2 \dfrac{R_B}{R_A}}$ $\boxed{F_4 = 529\,N}$

(5) $\Sigma M_{Dz} = 0 = (R_{Cy})(L_2 + L_3) - F_3(L_2) - F_2(L_1) = 0$

$\boxed{R_{Cy} = \dfrac{F_3 L_2 + F_2 L_1}{L_2 + L_3}}$ $\boxed{R_{Cy} = 295.5\,N}$

(7) $\Sigma F_y = 0 = F_2 - F_3 + R_{Dy} + R_{Cy} = 0$

$\boxed{R_{Dy} = F_3 - F_2 - R_{Cy}}$ $\boxed{R_{Dy} = -85.5\,N}$

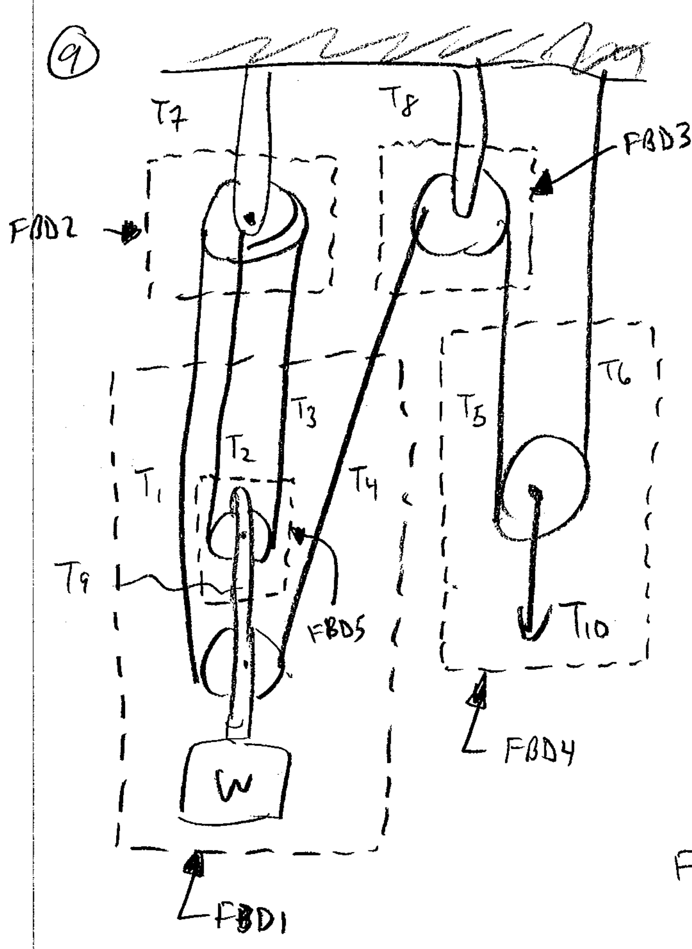
(6) $\Sigma M_{Dy} = 0 = -F_1 L_1 - F_4 L_2 - R_{Cz}(L_2 + L_3) = 0$

$\boxed{R_{Cz} = \dfrac{-F_1 L_1 - F_4 L_2}{L_2 + L_3}}$ $\boxed{R_{Cz} = -265.6\,N}$

(8) $\Sigma F_z = 0 = -F_1 + F_4 + R_{Dz} + R_{Cz}$

$\boxed{R_{Dz} = F_1 - F_4 - R_{Cz}}$ $\boxed{R_{Dz} = -153.4\,N}$

⑨



W = 780 lb

One rope, so $T_1 = T_2 = T_3 = T_4 = T_5 = T_6$

FBD1: $\Sigma F_y = 0$

$W = 4T_1$

$\boxed{T_1 = \frac{W}{4}}$

$\boxed{T_1 = T_2 = T_3 = T_4 = T_5 = T_6 = 195 \text{ lb}}$

FBD2: $T_7 = 3T_1 = 3\frac{W}{4} = T_7$

$\boxed{T_7 = 585 \text{ lb}}$

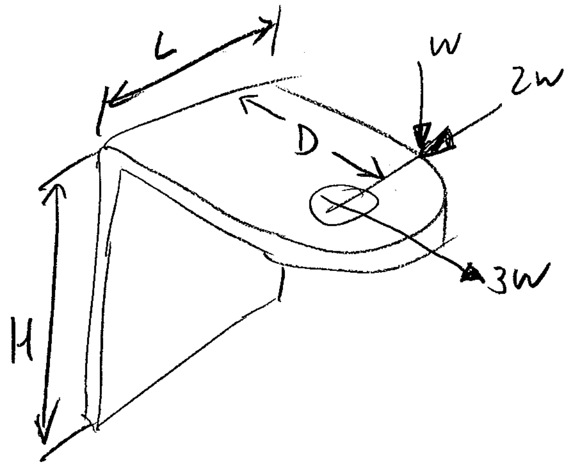
FBD3: $T_8 = 2T_1 = \frac{W}{2}$

$\boxed{T_8 = 390 \text{ lb}}$

FBD4: $T_{10} = 2T_1 \rightarrow \boxed{T_{10} = 390 \text{ lb}}$

FBD5: $T_9 = 2T_1 \rightarrow \boxed{T_9 = 390 \text{ lb}}$

(12) $H = 7cm$
$L = 5cm$
$D = 9cm$



$|F_{Ax}| = |3w| \rightarrow \boxed{w_{F_x} = \frac{F_{Ax}}{3} = \underline{933.3N}}$

$|F_{Ay}| = |-w| \rightarrow \boxed{w_{F_y} = 900N}$

$|F_{Az}| = |-2w| \rightarrow \boxed{w_{F_z} = 950N}$

$|M_{Ax}| = |2wH - w\frac{L}{2}|$

$\rightarrow w = \frac{|M_{Ax}|}{|2H - \frac{L}{2}|} = \boxed{956.5 N = w_{M_x}}$

$|F_{Ax}| \leq 2800N$
$|F_{Ay}| \leq 900N$
$|F_{Az}| \leq 1900N$
$|M_{Ax}| \leq 110 Nm$
$|M_{Ay}| \leq 140 Nm$
$|M_{Az}| \leq 280 Nm$

$|M_{Ay}| = |-2wD| \rightarrow \boxed{w_{M_y} = 777.8N}$

$|M_{Az}| = |-wD - 3wH| \rightarrow \boxed{w_{M_z} = 933.3N}$

True w_{MAX} is the smallest of these.... $\boxed{w_{MAX} = 777.8N}$