Name ANSWER KEY

Homework Questions
*Equilibrium #1*

1. A flexible chain weighing 40.0 N hangs between two hooks located at the same height. At each hook, the tangent to the chain makes an angle $\theta = 40.5°$ with the horizontal.

WHY ISN'T 1B ANSWER 46.8N? (ANSWER x 2 SINCE PULLED IN 2 DIRECTIONS.)


98N OF FT EXAMPLE = 1kg

(a) Find the magnitude of the force each hook exerts on the chain.

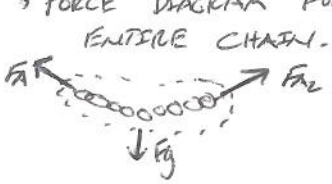
30.8 N

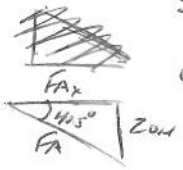
$F_{Ax} = F_{A2x}$

$F_{Ay} + F_{A2y} = F_g$

$20N + 20N = 40N$

• FORCE DIAGRAM FOR ENTIRE CHAIN.




$\sin 40.5 = \frac{20N}{F_A}$

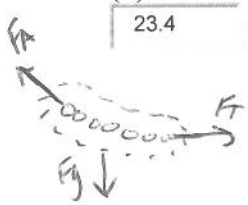
$F_A = 30.8N$

• WHY CAN'T WE DIAGRAM JUST THE FORCES ON THE MOST MIDDLE CHAIN LINK?

• NO LONGER ALL 40N OR 40.5°

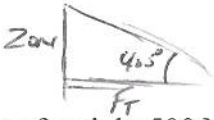
(b) Find the tension in the chain at its midpoint. (*Hint:* Make a free-body diagram for half the chain.)

23.4 N




$F_g = 20N$

$F_g = F_{Ty} = 20N$




$\tan(40.5°) = \frac{20N}{F_T}$

$F_T = 23.4N$

• HOW COME LAST YEAR ALL TENSIONS WERE EQUAL, BUT NOT HERE?

• CHAIN IS NOT MASSLESS

2. A bag of cement of weight 500 N hangs from three wires as shown below. Two of the wires make angles $\theta_1 = 60.0°$ and $\theta_2 = 21.0°$ with the horizontal. If the system is in equilibrium, find the tensions in the wires.

$T_1$ 473 N

$T_2$ 253 N

$T_3$ 500 N

• SOLVE $T_3$ (500N)

• WRITE X-EQN ($F_{T1x} = F_{T2x}$)

• SUBSTITUTE ($F_{T1}\cos\theta_1 = F_{T2}\cos\theta_2$)

• WRITE Y-EQN ($F_g = F_{T1y} + F_{T2y}$)

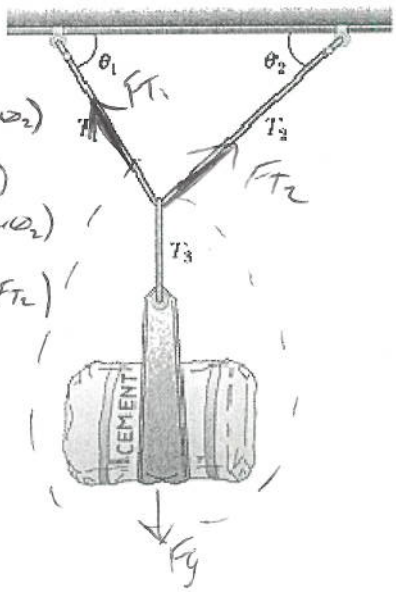
• SUBSTITUTE ($F_g = F_{T1}\sin\theta_1 + F_{T2}\sin\theta_2$)

• SOLVE FOR $F_{T1}$ ($F_{T1} = \frac{\cos\theta_2}{\cos\theta_1} F_{T2}$)

• SIMPLIFY ($F_{T1} = 1.86 F_{T2}$)

• PLUG $1.86F_{T2}$ INTO y-EQN FOR $F_{T1}$ TO FIND $F_{T2}$.

• PLUG $F_{T2}$ INTO X-EQN TO FIND $F_{T1}$




• HOW WOULD THIS PROBLEM BE DIFF. IF THE $T_3$ CORD WASN'T THERE? IF $T_3$ HAD MASS?

• NO CHANGE

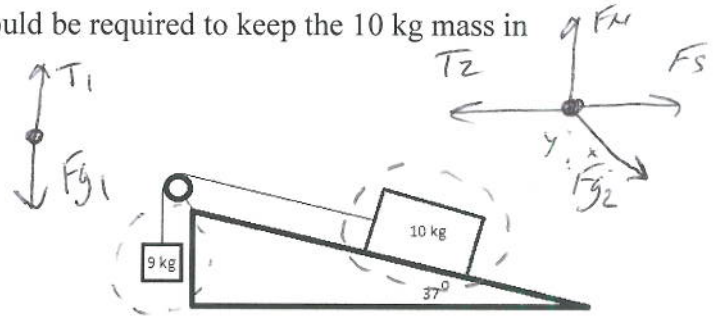
• COULDN'T USE 500N ANYMORE.

ROTATED

3. What minimum coefficient of static friction would be required to keep the 10 kg mass in place on the incline?

Minimum Coefficient:

0.37




$T_2 = F_{g2x} + F_s$

$T_1$ ↓ $F_{g1}$

$F_{g2x}$ ↓ $F_{g2}\,SIN(37)$

$\mu_s F_N$ ↓ $F_{g2}\cos(37)$

| 9kg | 10 kg |
|---|---|
| $T_1 = F_{g1}$ | $F_N = F_{g2y}$ |
| | $T_2 = F_{g2x} + F_S$ |
| $T_1 = T_2$ ⇒ SAME ROPE! | |

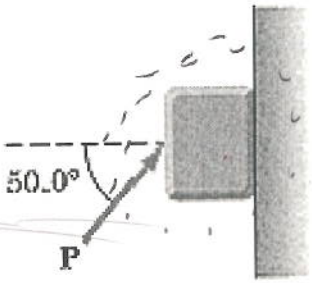
$(9kg)(9.8N/kg) = (10kg)(9.8N/kg)\sin(37) + \mu_s(10kg)(9.8N/kg)\cos(37)$

$\mu_s = 0.37$

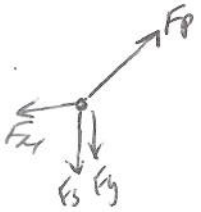
4. A block of mass 2.00 kg is pushed up against a wall by a force **P** that makes a 50.0° angle with the horizontal as shown below. The coefficient of static friction between the block and the wall is 0.255. Determine the possible values for the magnitude of **P** that allow the block to remain stationary.

32.6 N (maximum)

21.1 N (minimum)




MAXIMUM



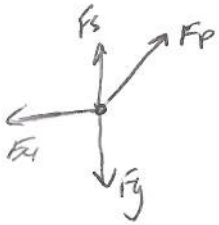

x/ $F_N = F_{Px}$

y/ $F_S + F_g = F_P$

⇒ SOLVE FOR $F_P$

* $F_S$ WORKS AGAINST YOUR PUSH AND WITH GRAVITY

MINIMUM




x/ $F_N = F_{Px}$

y/ $F_S + F_{Py} = F_g$

⇒ $F_S$ WORKS WITH YOUR PUSH AND AGAINST GRAVITY.