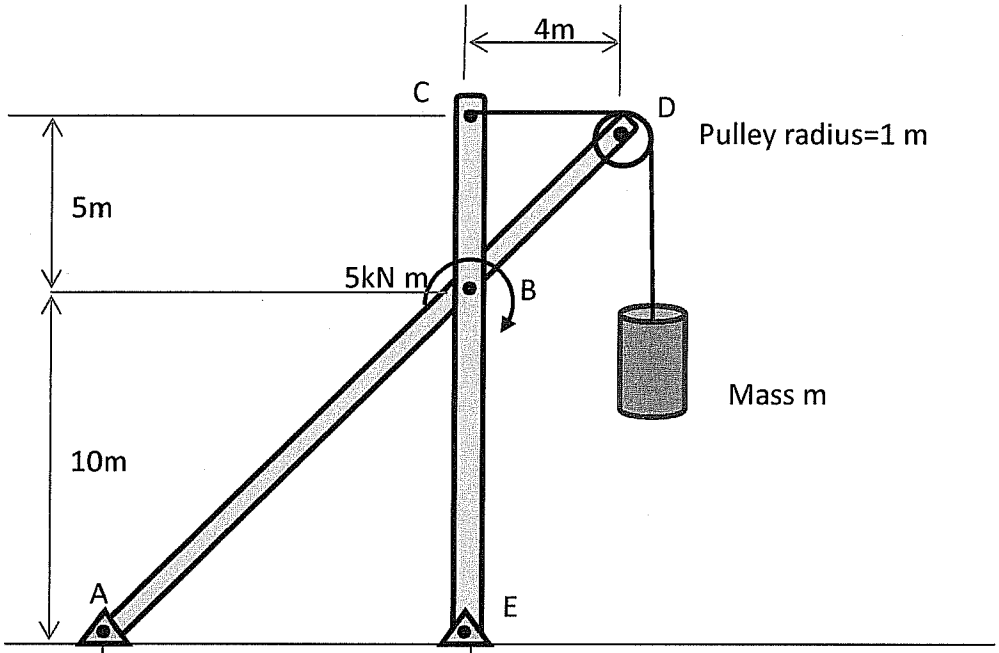
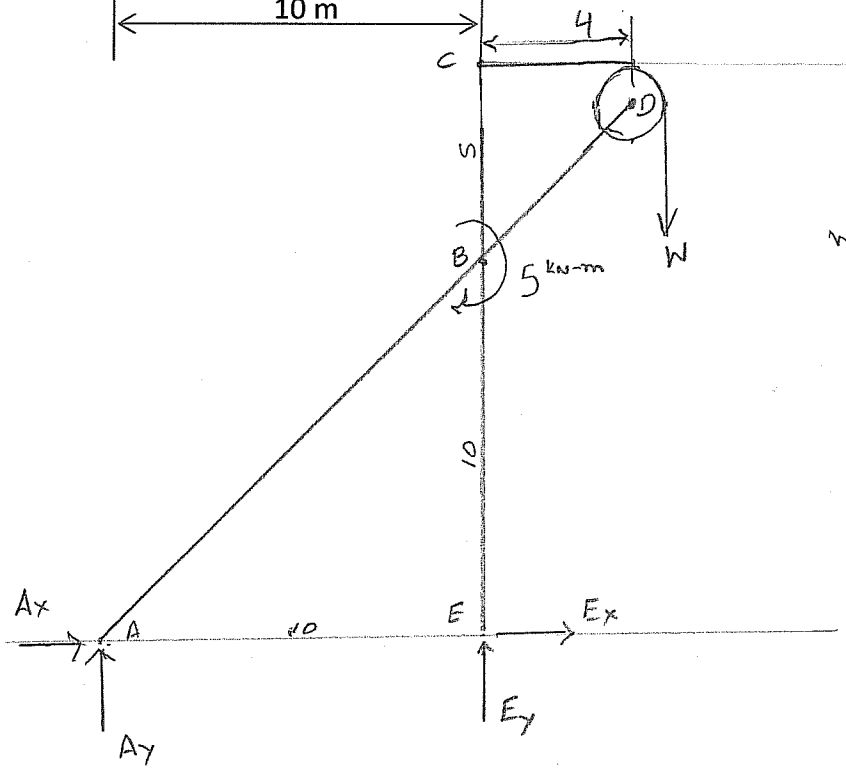
SOLUTION

THE UNIVERSITY OF MANITOBA **NAME:**_____
SN:_____
Faculty of Engineering
ENG 1440 Introduction to Statics **GROUP NO:** _____
March 13, 2013
Term Test # 2 Time: 6:00 pm – 7:30 pm





$W = mg$

Forces in kN

$[\Sigma F_x = 0]$ $A_x + E_x = 0$ $A_x = -E_x$ ①

$[\Sigma F_y = 0]$ $A_y + E_y - W = 0$ $A_y + E_y = W$ ②

$[\Sigma M_A = 0]$ $10E_y - 5 - 15W = 0$ $E_y = \frac{5+15W}{10} = 0.5 + 1.5W$ ③

$\therefore A_y = -(0.5 + 0.5W)$

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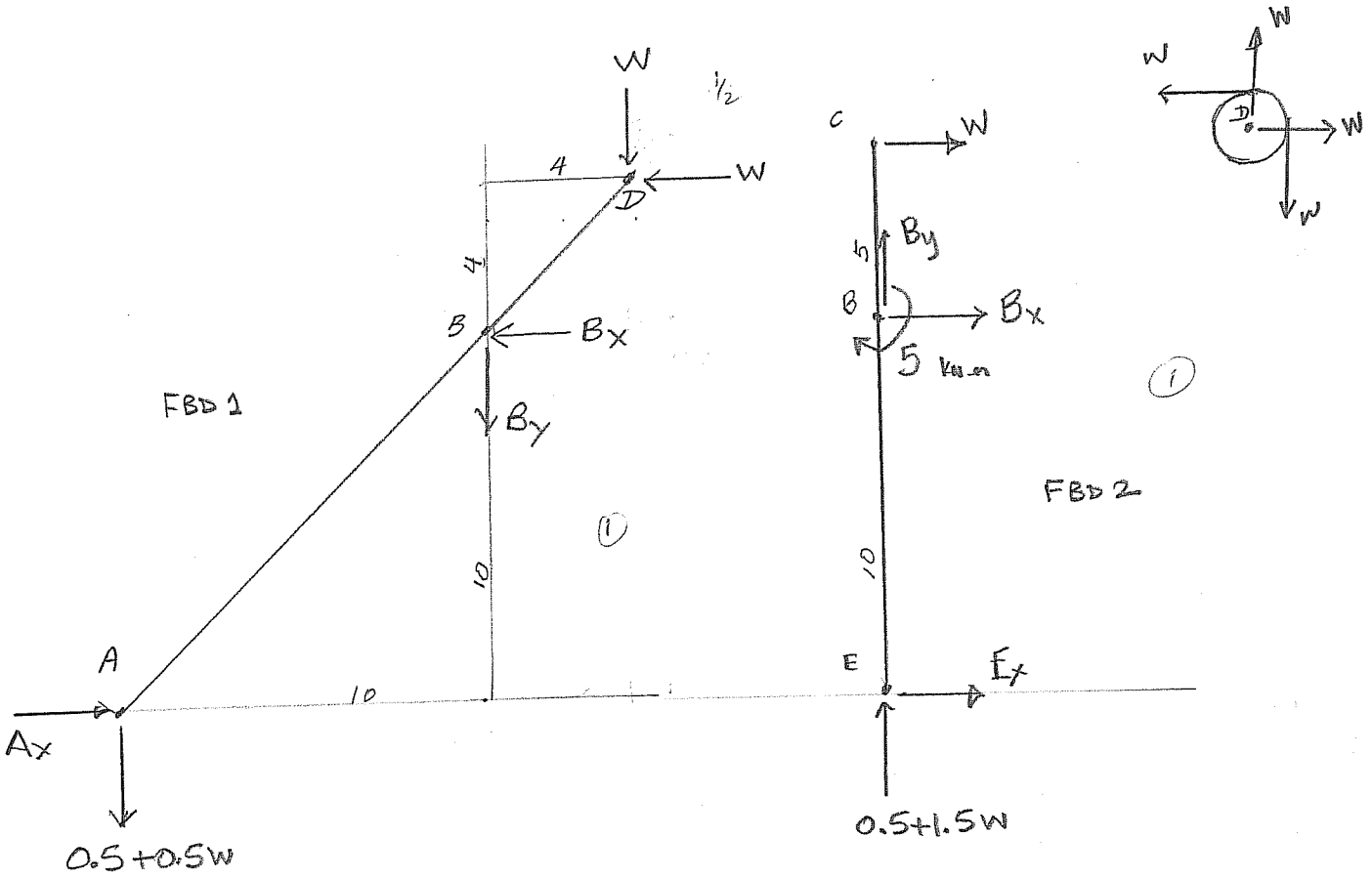

(Forces in KN)

$[\Sigma F_x = 0]$ $A_x - B_x - W = 0$

$A_x - B_x = W$ (4)

$[\Sigma F_y = 0]$ $-(0.5+0.5W) - B_y - W = 0$

$B_y = -0.5 - 1.5W$ (5)

$[\Sigma M_{B=0}]$ $10A_x + 10(0.5+0.5W) +$

$+4W - 4W = 0$

$A_x = -0.5 - 0.5W$ (6)

From (4) $B_x = A_x - W = -0.5 - 0.5W - W$

$= -0.5 - 1.5W$

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Force on pin at B.

$B_x = -0.5 - 1.5W$

$B_y = -0.5 - 1.5W$

$\text{Resultant} = \sqrt{B_x^2 + B_y^2}$

$= (0.5 + 1.5W)\sqrt{2}$

Max. capacity $= 20000\ N = 20\ kN$

$20 = (0.5 + 1.5W)\sqrt{2}$

$W = 9.095\ kN$

$m = \frac{W}{g} = \frac{9095}{9.8} = 928\ kg$ ◀

Check accuracy of forces at B.

From Eq. 1 $A_x = -E_x \quad \therefore E_x = -(-0.5 - 0.5W) = 0.5 + 0.5W$

From FBD (2) :

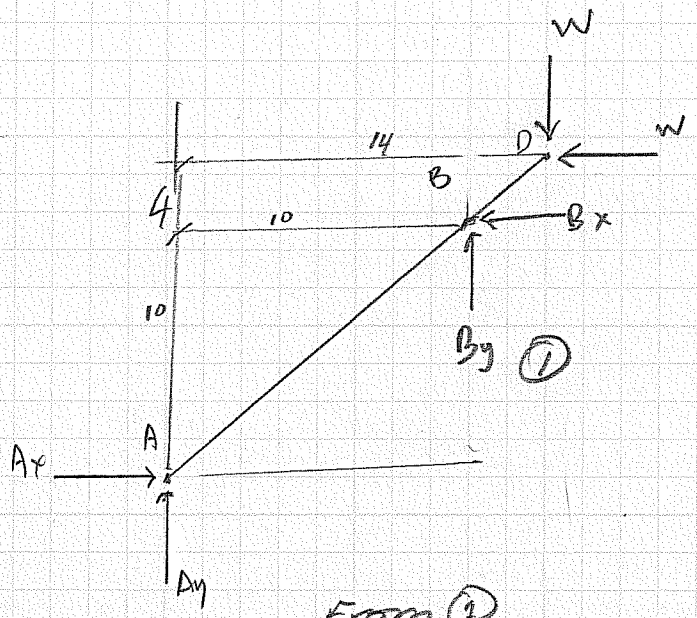
$\Sigma F_x = W + B_x + E_x = W - 0.5 - 1.5W + 0.5 + 0.5W = 0$ ✓

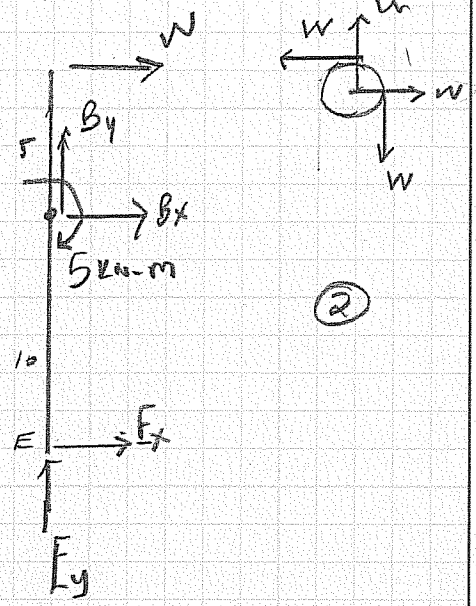
$\Sigma F_y = B_y + 0.5 + 1.5W = -0.5 - 1.5W + 0.5 + 1.5W = 0$ ✓

$\Sigma M_E = -15W - 10B_x - 5 = -15W - 10(-0.5 - 1.5W) - 5 = 0$ ✓

All check

Alternate Solution





From ①

$(\Sigma M_B = 0)$ $\quad -10A_y + 10A_x - 4W + 4W = 0$

$A_x = A_y$ (1)

$(\Sigma F_x = 0)$ $\quad A_x - B_x - W = 0 \quad A_x - B_x = W$ (2)

$[\Sigma F_y = 0]$ $\quad A_y + B_y - W = 0 \quad A_y + B_y = W$ (3)

$\therefore A_x - B_x = A_y + B_y$

Since $A_x = A_y$, $B_x = -B_y$

from ② $(\Sigma M_E = 0)$ $\quad -5000 - 10B_x - 15W = 0$

$$B_x = -\frac{5000 - 15W}{10}$$

$$= -500 - 1.5W$$

$$B = \sqrt{B_x^2 + B_y^2} = |B_x|\sqrt{2} = (500 + 1.5W)\sqrt{2} = 2000$$

$W = 909.5\ N$

$m = 92.8\ kg$

(FBD 2)

$(\Sigma M_E = 0)$ $-10B_x - 5 - 15W = 0$

$10B_x = -5 - 15W$

$B_x = -0.5 - 1.5W$

$(\Sigma F_y = 0)$ $0.5 + 1.5W + B_y = 0$

$B_y = -0.5 - 1.5W$

$B_x = B_y$

$$20000 = \sqrt{B_x^2 + B_y^2} = (0.5 + 1.5W)\sqrt{2}$$

$W = 9.095$ kN

$m = 928$ kg

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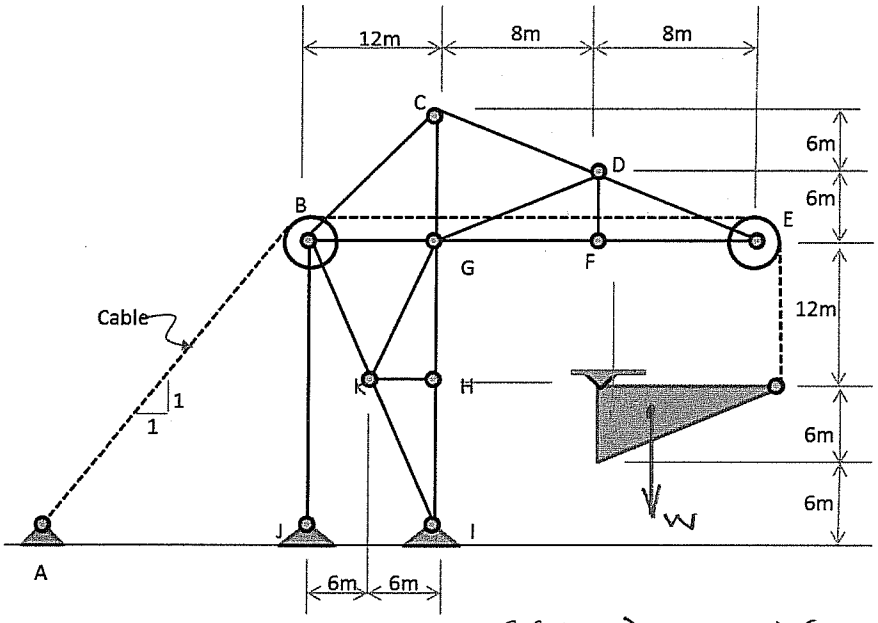
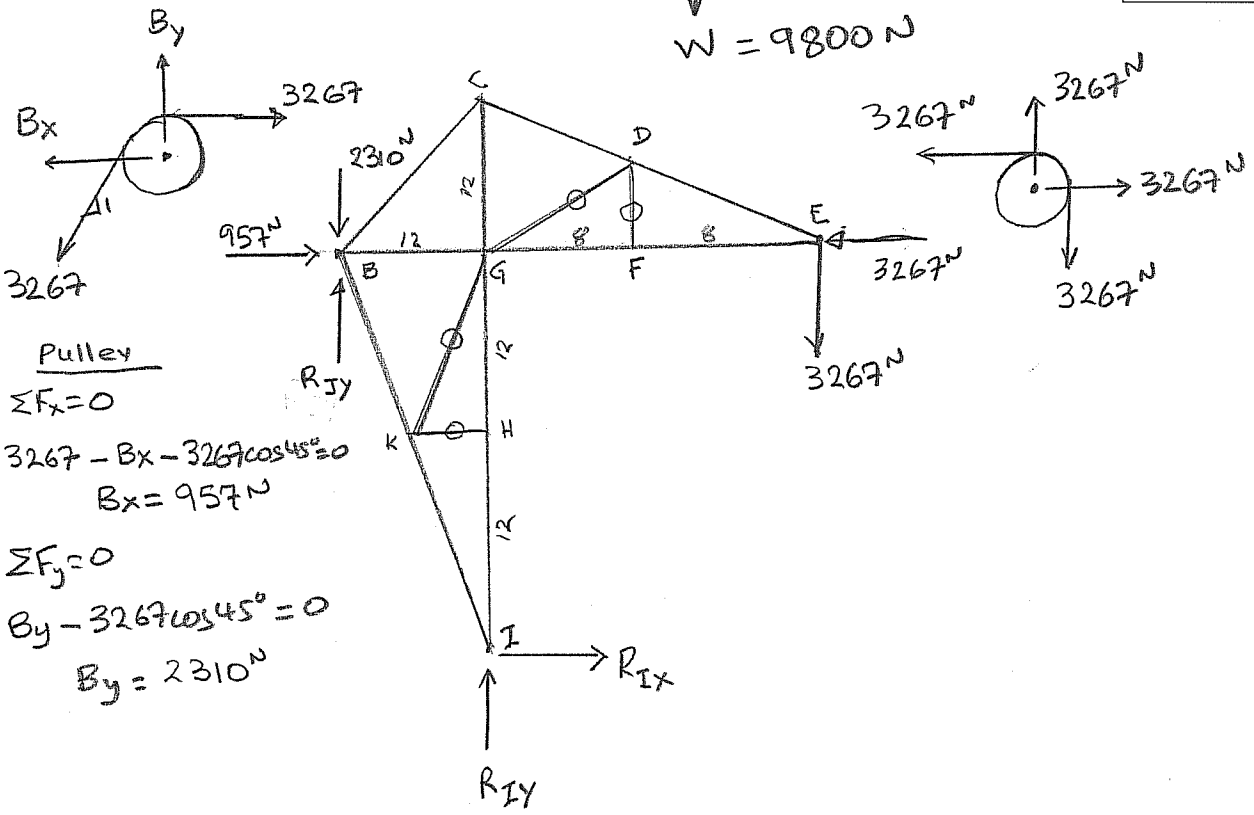


Truss Summary of the results	
Member	Force
JB	2574 C
BC	6160 T
CD	5445 T
DE	5445 T
EF	7623 C
FD	0
FG	7623 C
GC	7623 C
GD	0
GB	7623 C
GH	7623 C
HK	0
HI	7623 C
IK	5165 T
KB	5165 T
KG	0

$\frac{2}{3}(9800) = 6533\ N$

$\frac{1}{3}(9800) = 3267\ N$

$W = 9800\ N$



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$[\Sigma F_x = 0]$ $957 + R_{Ix} - 3267 = 0$ $\boxed{R_{Ix} = 2310^{N}}$ (1)

$[\Sigma F_y = 0]$ $-2310 + R_{Jy} + R_{Iy} - 3267 = 0$

$R_{Jy} + R_{Iy} = 5577$ (2)

$[\Sigma M_I = 0]$ $-12R_{Jy} + 12(2310) - 24(957) - 16(3267) + 24(3267) = 0$

$-12R_{Jy} + 30888 = 0$

$\boxed{R_{Jy} = 2574\,N}$ (3)

From (2) $\boxed{R_{Iy} = 3003\,N}$ (4)

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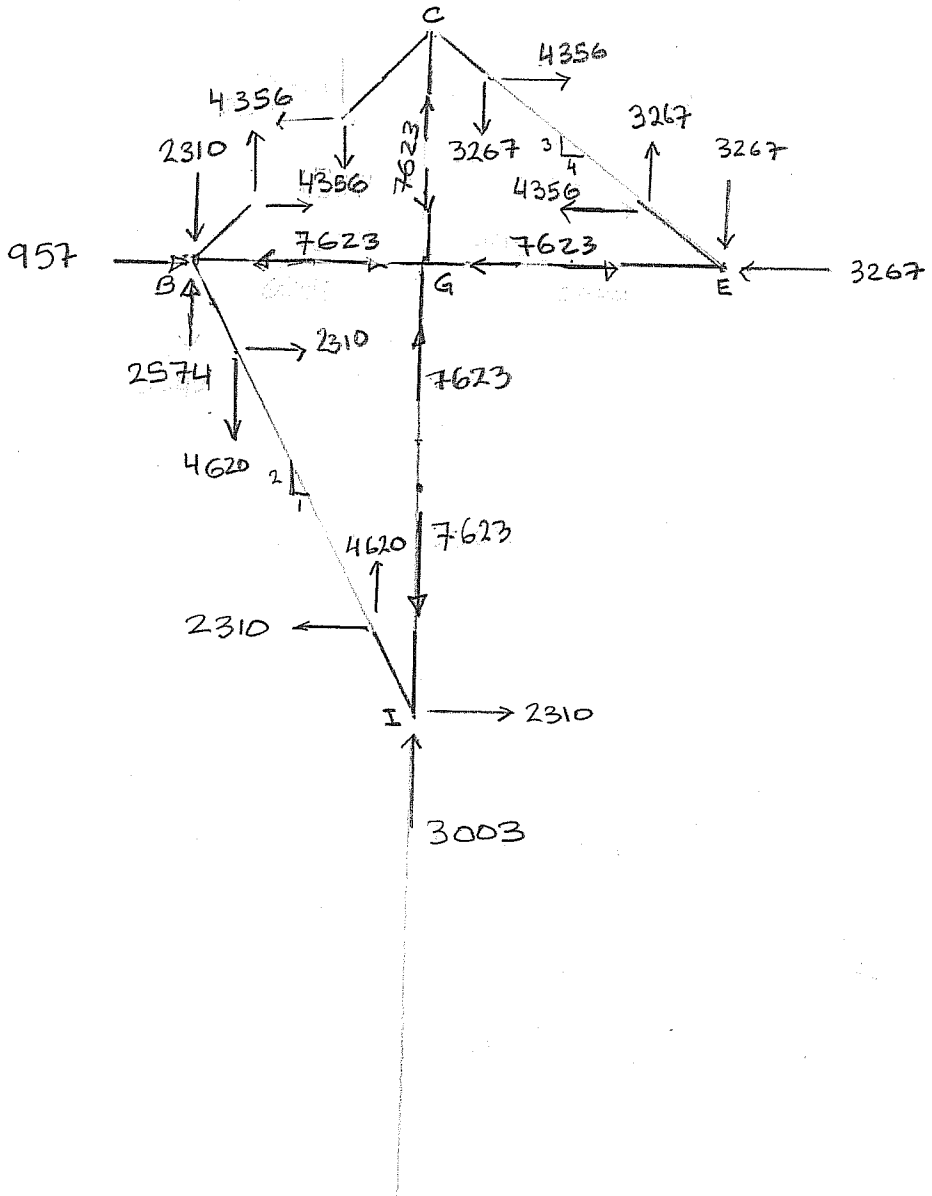

(All forces in N)