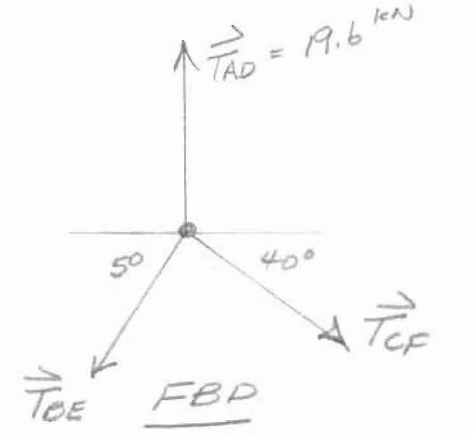
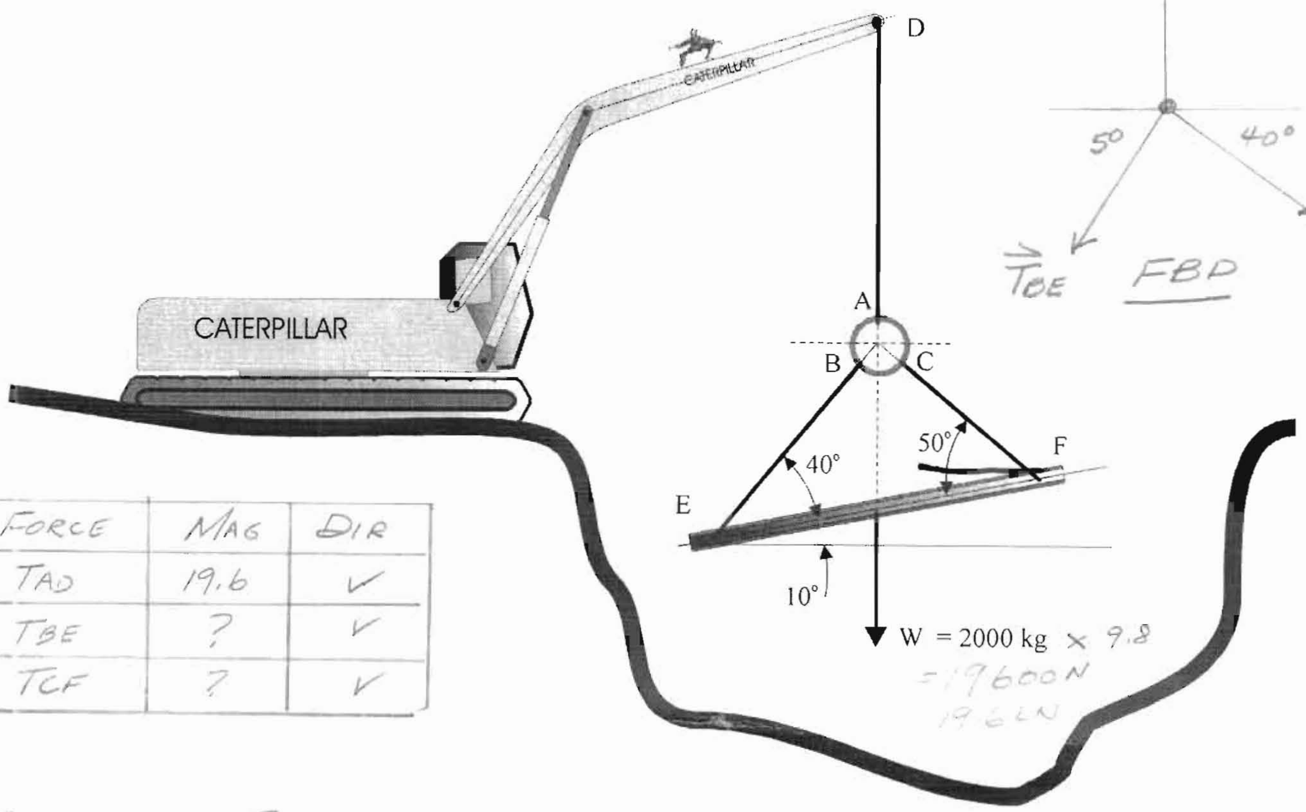
QUESTION 1

A crane is lifting a *2000 kg* steel beam. Determine the forces in the three cables (*AD*, *BE* and *CF*) attached to the ring at *A*, *B*, and *C* if the resultant of these three forces acting on the ring is zero when the beam is in the position shown in the figure below. Neglect the radius of the ring.

a) Present a graphical solution to this problem and state the scale you are using.
b) Present a trigonometry solution.

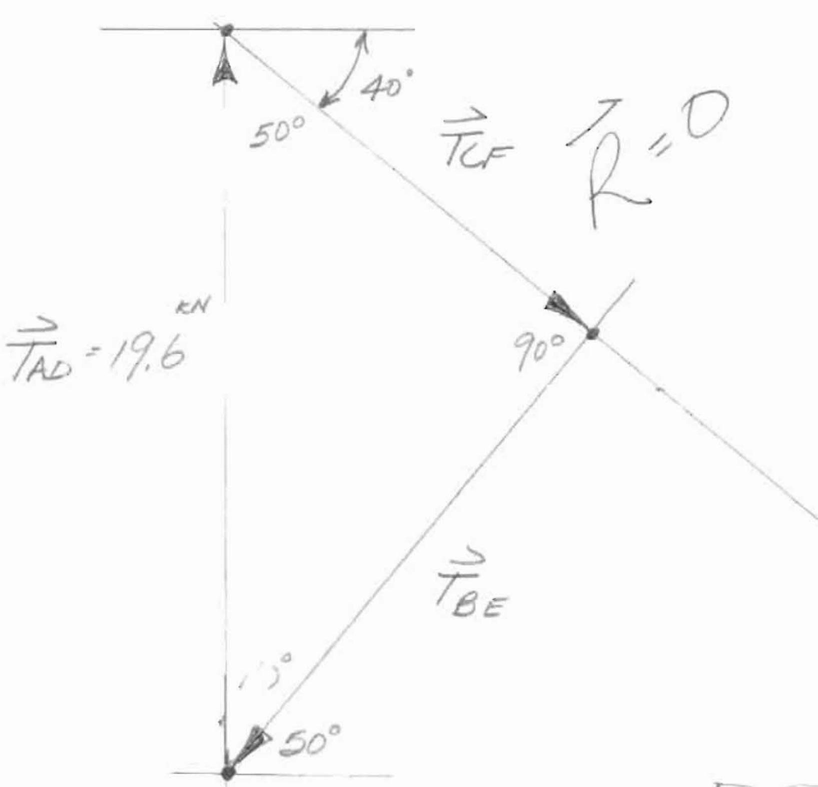
Use g (gravity acceleration) = 9.8 m/sec^2





FORCE	MAG	DIR
T_{AD}	19.6	✓
T_{BE}	?	✓
T_{CF}	?	✓

a) GRAPHICAL SOLN



SCALE 1:20 Metric

$\vec{T}_{AD} = 19.6$ kN ↓

$\vec{T}_{CF} = 12.5$ kN 40°

$\vec{T}_{BE} = 15.1$ kN 50°

b) TRIG SOLN

90° TRIANGLE

$T_{CF} = 19.6 \cos 50°$

$\vec{T}_{CF} = 12.6$ kN 40°

$\vec{T}_{BE} = 19.6 \sin 50°$

$= 15.01$ kN 50°

$\vec{T}_{AD} = 19.6$ kN ↑

Check # 2 By Rectangular Components Equilibrium

$\Sigma F_x = 0 \quad -T_{BE} \cos 50° + T_{CF} \cos 40° = 0$

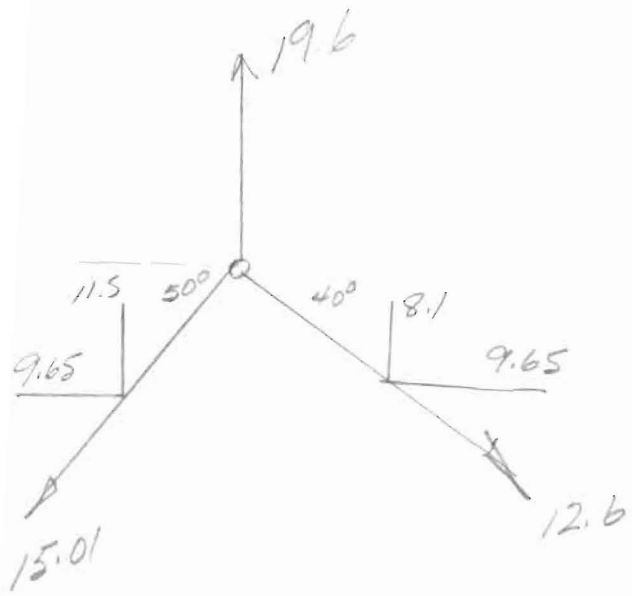
$\Sigma F_y : 0 \quad 19.6 - T_{BE} \sin 50 - T_{CF} \sin 40° = 0$

$T_{CF} = \frac{T_{BE} \cos 50°}{\cos 40°} = 0.8391\, T_{BE}$

$19.6 - T_{BE} \sin 50 - 0.8391\, T_{BE} \sin 40° = 0$

$T_{BE} = \frac{19.6}{1.305} = 15.01$ kN

$0.8391(15.01) = 12.$ kN

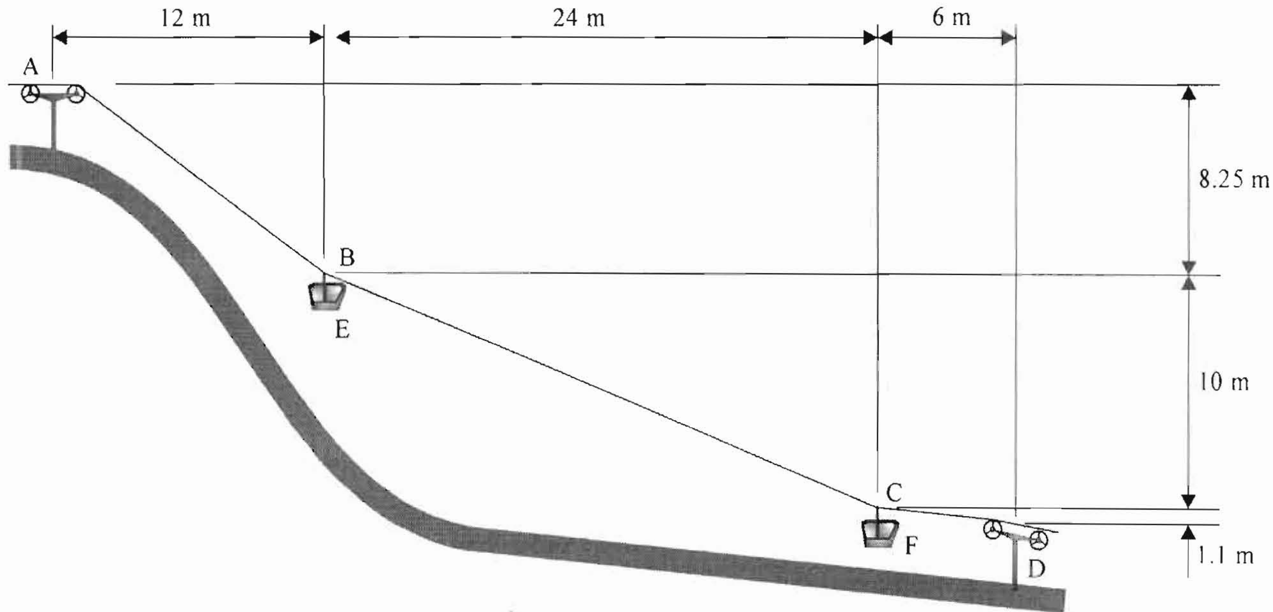


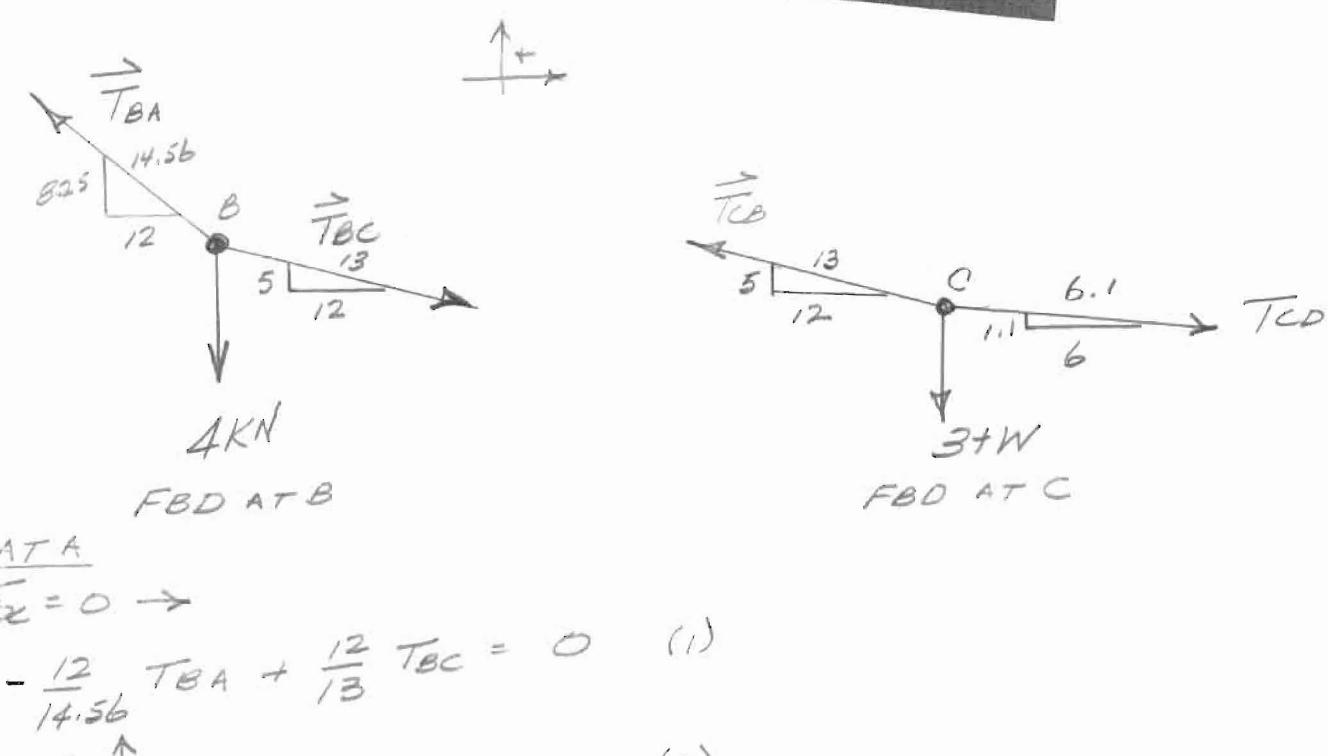
$\Sigma F_x = 0$ ✓

$\Sigma F_y = 0$ ✓

QUESTION 2

A gondola lift is stopped in the position shown. If each gondola weighs *3 kN* and the weight of people in the gondola *E* attached at *B* is *1 kN*. Determine the weight of people in the gondola *F* attached at *C*. **FREE BODY DIAGRAMS DRAWN WITH A STRAIGHT EDGE ARE NECESSARY AND INDICATE x and y AXES.**





FBD AT B FBD AT C

FBD AT A

$\Sigma F_x = 0 \rightarrow$

$$-\frac{12}{14.56} T_{BA} + \frac{12}{13} T_{BC} = 0 \quad (1)$$

$\Sigma F_y = 0 \uparrow$

$$\frac{8.25}{14.56} T_{BA} - \frac{5}{13} T_{BC} - 4 = 0 \quad (2)$$

From (1) $T_{BA} = \frac{14.56}{12}\left(\frac{12}{13} T_{BC}\right) = 1.12\, T_{BC}$

$\therefore$ FROM (2) $\frac{8.25}{14.56}\left(1.12 T_{BC}\right) - \frac{5}{13} T_{BC} = 4$

$0.25\, T_{BC} = 4$ $T_{BC} = 16^{kN}$

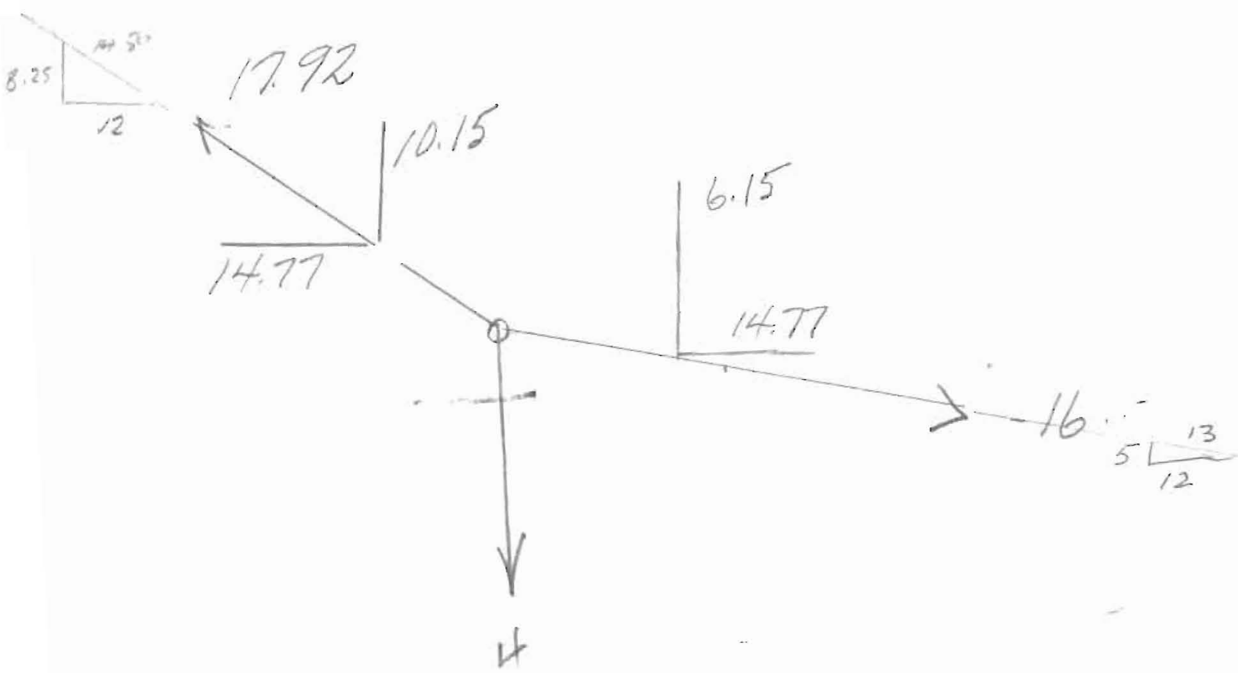
$\therefore$ $T_{BA} = 1.12\,(16) = 17.92^{kN}$

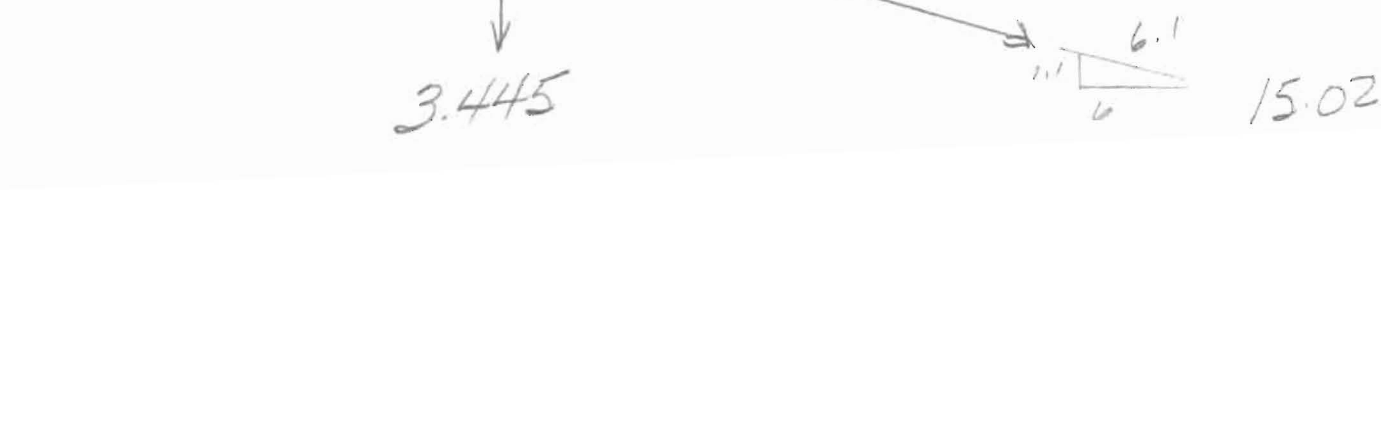
FBD AT B $\Sigma F_x = 0$ $-\frac{12}{13}(16) + \frac{6}{6.1} T_{CD} = 0$

$T_{CD} = \frac{12}{13}(16)\left(\frac{6.1}{6}\right) = 15.02^{kN}$

$\Sigma F_y = 0$ $\frac{5}{13}(16) - \frac{1.1}{6.1} T_{CD} - (3+W) = 0$

$W = 6.154 - \frac{1.1}{\;}(15.02) - 3$ $W = 0.445^{kN}$


17.92
10.15
14.77
6.15
14.77
16
8.25
12
13
5
12
4


16
6.15
14.77
2.71
14.77
3.445
6.1
1.1
6
15.02

QUESTION 3

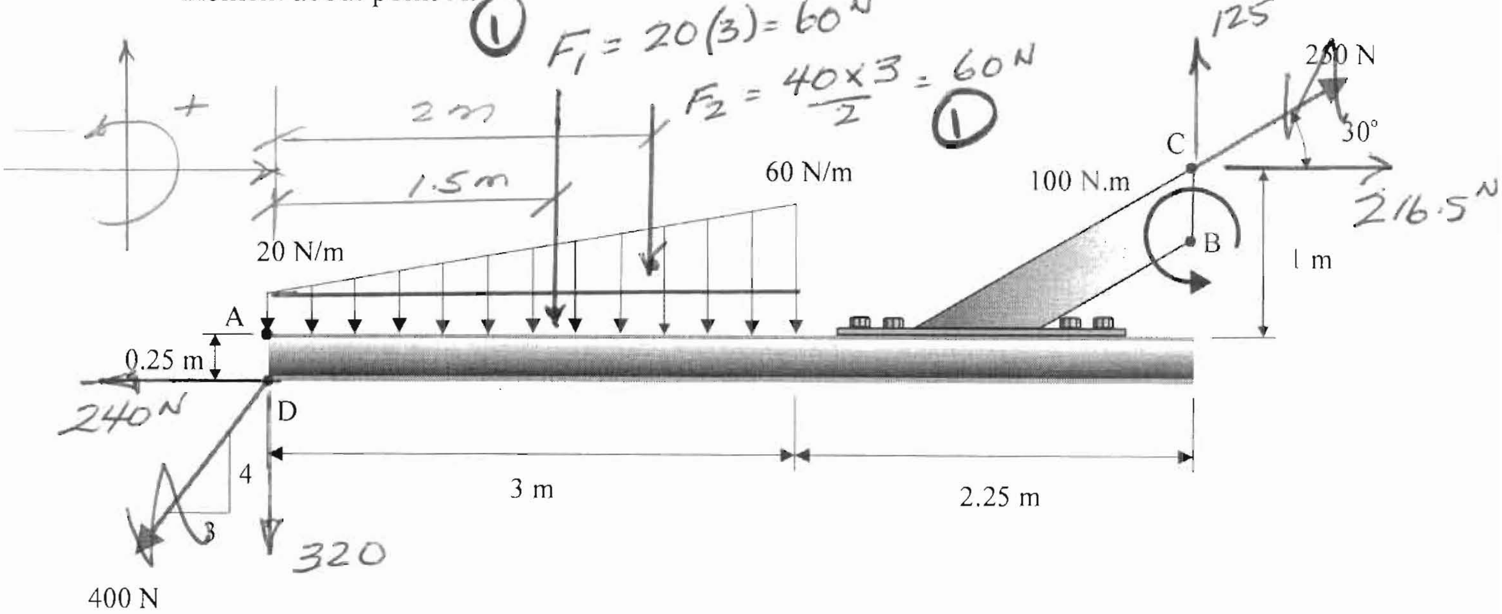
A distributed load that varies from 20 N/m to 60 N/m is applied to a beam as shown in the figure. A 400 N force is applied at Point D. A 100 N.m couple-moment and a 250 N force act on a bracket that is attached by bolts to the beam.

Determine:

a) The equivalent force-couple at point A, and
b) The magnitude and direction of the minimum force applied at Point C that will produce the same moment about point A.

$F_1 = 20(3) = 60^N$ (1)

$F_2 = \frac{40 \times 3}{2} = 60N$ (1)



a) $\vec{R}_x = \Sigma F_x = -240 + 216.5 = -23.5^N$ (1)

$\vec{R}_x = 23.5^N \leftarrow$

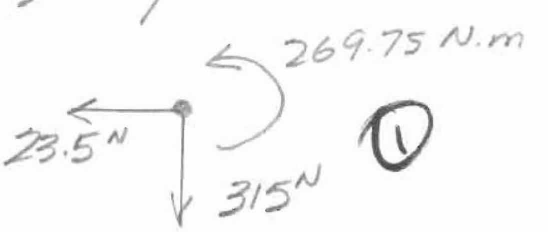
$\vec{R}_y = \Sigma F_y = -320 - 60 - 60 + 125 = -315^N$ (1)

$\vec{R}_y = 315^N \downarrow$

$\vec{M}_{R_A} = -240(0.25) - 60(1.5) - 60(2)$
$+ 125(5.25) - 216.5(1) + 100$
$= +269.75\ N.m$

$\vec{M}_{R_A} = 269.75\ N.m$ ↺ (2)

a) Equivalent Force Couple at A

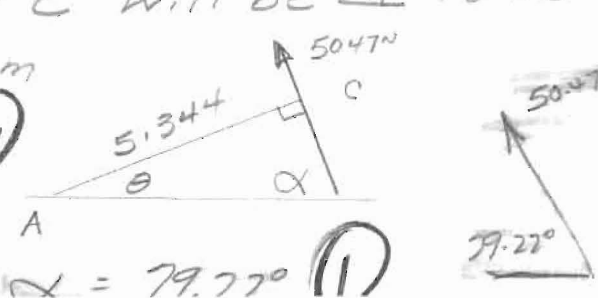


(1)

b) Minimum force applied at C will be ⊥ to AC

$\overline{AC} = \sqrt{5.25^2 + 1^2} = 5.344\ m$

$M = Fd \quad F = \frac{269.75}{5.344} = 50.47^N$ (2)



$\tan\theta = \frac{1}{5.25} \quad \theta = 10.78°$

$\alpha = 79.22°$ (1)