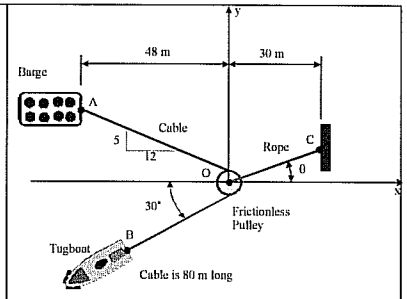
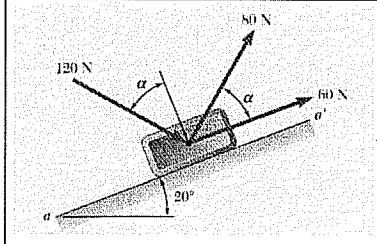
Engineering Statics
Assignment #2 SOLUTION

1) A tugboat is pulling a barge with a *80 m* long cable in the configuration shown in the figure. The cable is attached to the barge at *A* and wraps around a frictionless pulley and is attached to the tugboat at *B*. (Neglect the radius of the pulley.) The pulley is attached to the dock by the rope *OC*. The cable breaks when the tension in the cable reaches *1000N*.

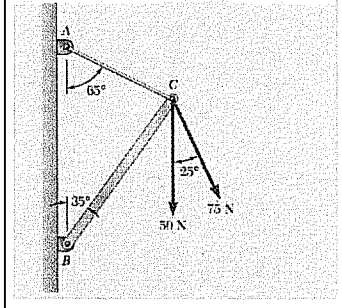
Determine the tension in the rope *OC* and the angle θ at the instant the cable breaks using, rectangular components



1) Knowing $\alpha = 40°$, determine the resultant of the three forces shown using rectangular components.



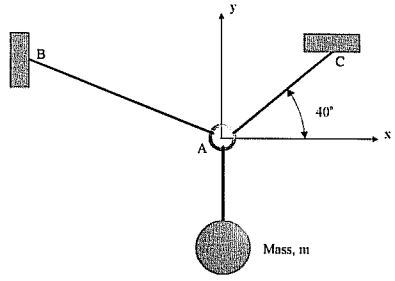
2) Determine the required tension in cable AC, knowing that the resultant of the three forces exerted at point C of the boom BC must be directed along BC, and the corresponding magnitude of the resultant using rectangular components.



4) A mass, *m*, is suspended from a circular ring that is attached to supports by cables *AB* and *AC* as shown in the figure. The force in cable *AB* is 538.5 N.

Knowing that the point *A* is in equilibrium, determine the mass, *m* and the magnitude of the force in cable *AC* by each of the following methods using rectangular components

Note: g = 9.8 m/sec^2
Also, the coordinates of B are (-500, 200) mm



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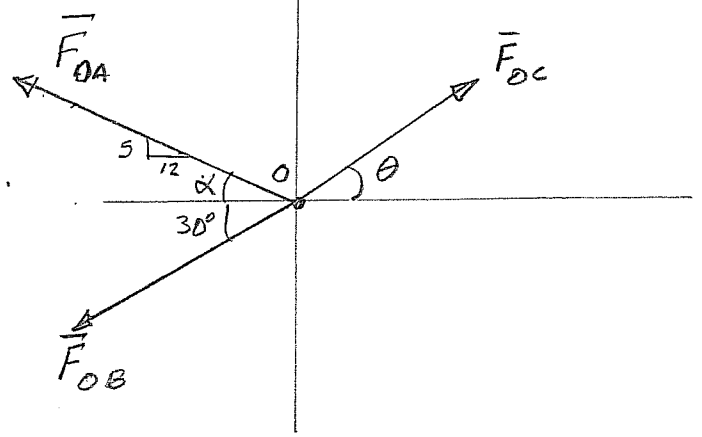
1)



$\tan\alpha = \frac{5}{12}$ $\alpha = 22.6°$

Force $\bar{F}$	Force Magn. (N)	F_x (N)	F_y (N)
$\bar{F}_{OA}$	1000	$-1000\cos\alpha$ $= -923.2$	$+1000\sin\alpha$ $= 384.3$
$\bar{F}_{OB}$	1000	$-1000\cos 30$ $= -866.0$	$-1000\sin 30°$ $= -500.$
$\bar{F}_{OC}$	F_{OC}	$F_{OC}\cos\theta$	$F_{OC}\sin\theta$
$\bar{R}$	0	0	0

$[\Sigma F_x = 0]$ $-923.2 - 866.0 + F_{OC}\cos\theta = 0$ (1)

$[\Sigma F_y = 0]$ $384.3 - 500 + F_{OC}\sin\theta = 0$ (2)

From (1) $F_{OC}\cos\theta = 1789.2$ (3)

From (2) $F_{OC}\sin\theta = 115.7$ (4)

(4) ÷ (3) $\frac{F_{OC}\sin\theta}{F_{OC}\cos\theta} = \frac{115.7}{1789.2}$ $\Rightarrow \tan\theta = 0.0647$

$\theta = 3.7°$ (5)

Sub (5) into (3) $F_{OC} = 1792.9$ N

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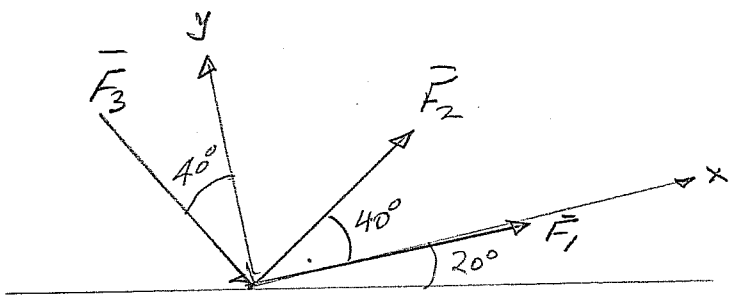
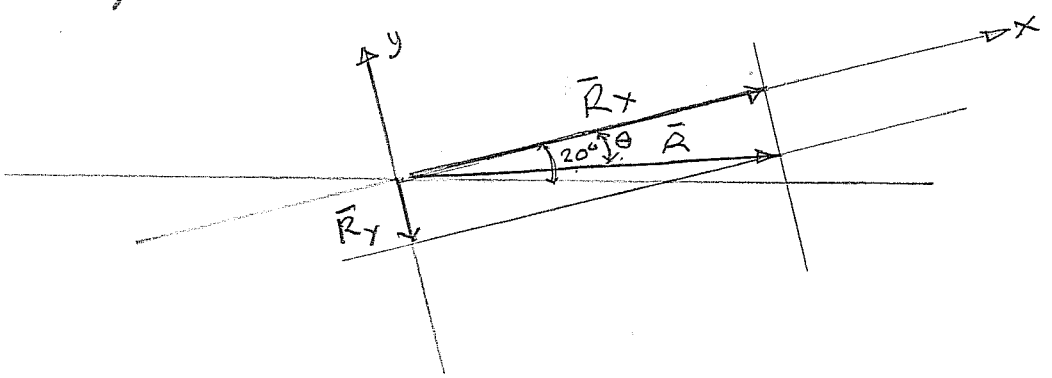


Force $\bar{F}$	Magn. (N)	F_x (N)	F_y (N)
$\bar{F}_1$	60	60	0
$\bar{F}_2$	80	$80 \cos 40$ $= 61.3$	$80 \sin 40°$ $= 51.4$
$\bar{F}_3$	120	$120 \cos 50°$ $= 77.1$	$-120 \cos 40°$ $= -91.9$
$\bar{R}$	R	R_x	R_y

$R_x = \Sigma F_x = 60 + 61.3 + 77.1 = 198.4\ N$

$R_y = \Sigma F_y = 0 + 51.4 - 91.9 = -40.5\ N$



$R = \sqrt{R_x^2 + R_y^2} = 202.5\ N$ ◀

$\tan\theta = \frac{|R_y|}{|R_x|} = \frac{40.5}{198.4}$ $\quad \theta = 11.5°$

Direction of Resultant $+ (20 - 11.5) = 8.5°$ from horizontal

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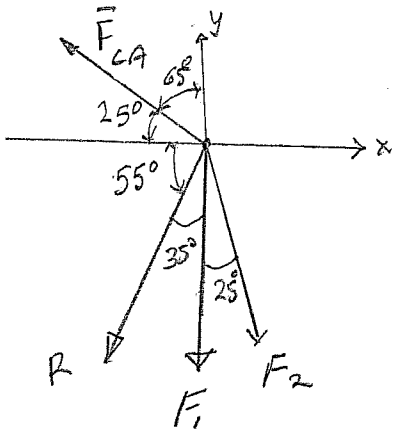

$\bar{F}_N$	$F(N)$	F_x (N)	F_y (N)
$\bar{F}_1$	50	0	−50
$\bar{F}_2$	75	$75 \sin 25° = 31.7$	$-75 \cos 25° = -68.0$
$\bar{F}_{CA}$	F_{CA}	$-F_{CA} \cos 25° = -0.9063 F_{CA}$	$F_{CA} \cos 65° = 0.4226 F_{CA}$
$\bar{R}$	R	$-R \cos 55° = -0.5736 R$	$-R \cos 35° = -0.8191 R$

$[\Sigma F_x = R_x]$ $\quad 31.7 - 0.9063 F_{CA} = -0.5736 R$ (1)

$[\Sigma F_y = R_y]$ $\quad -50 - 68.0 + 0.4226 F_{CA} = -0.8191 R$ (2)

From (1) $\quad F_{CA} = \dfrac{-0.5736R - 31.7}{-0.9063} = 0.6329 R + 34.98$ (3)

From (2) $\quad F_{CA} = \dfrac{-0.8191 R + 118.0}{0.4226} = -1.9382 R + 279.22$ (4)

(3) = (4) $\quad 0.6329R + 34.98 = -1.9382 R + 279.22$

$\therefore R = 95.0$ N ◀ (4)

Subst (4) into (3) $\quad F_{CA} = 95.1$ N ◀

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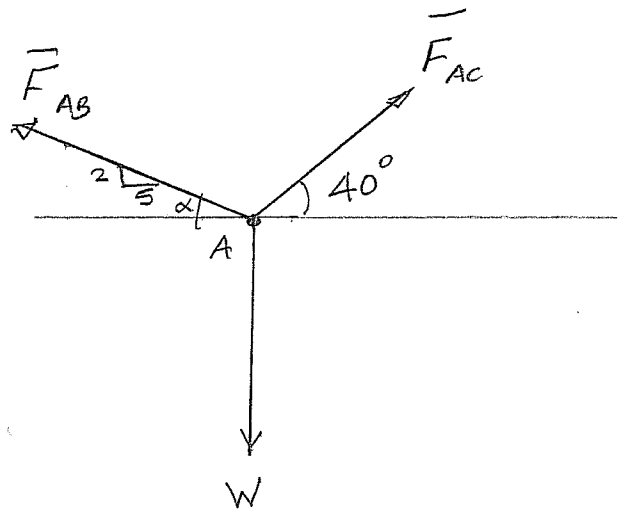

$$\tan\alpha = \frac{200}{500}$$

$$\alpha = 21.8^\circ$$

$\bar{F}$	F (N)	F_x (N)	F_y (N)
$\bar{F}_{AB}$	538.5	$-538.5\cos\alpha = -500.0$	$538.5\sin\alpha = 200.0$
$\bar{F}_{AC}$	F_{AC}	$F_{AC}\cos 40^\circ = 0.7660 F_{AC}$	$F_{AC}\sin 40^\circ = 0.6428 F_{AC}$
$\bar{W}$	W	0	$-W$
$\bar{R}$	0	0	0

$[R_x = \Sigma F_x = 0]$ $\quad -500.0 + 0.7660 F_{AC} = 0$ $\quad (1)$

$[R_y = \Sigma F_y = 0]$ $\quad 200.0 + 0.6428 F_{AC} - W = 0$ $\quad (2)$

From (1) $\quad F_{AC} = 652.7$ N ◀ $\quad (3)$

Subs (3) into (2) $\quad W = 619.6$ N

$$\therefore m = \frac{W}{g} = 63.2 \text{ kg} \blacktriangleleft$$