2.52 A force of 500 lb ,directed along the axis of the boom from A to O

$F = -500 lb; \alpha = 35°; \beta = 65°$

$F_y = F\cos\alpha = -500\cos 35°$

$F_y = -410 lb$

$F_h = F\sin\alpha = -500\sin 35°$

$F_h = -287 lb$

$F_x = F_h \sin\beta = -287\sin 65°$

$F_x = -260 lb$

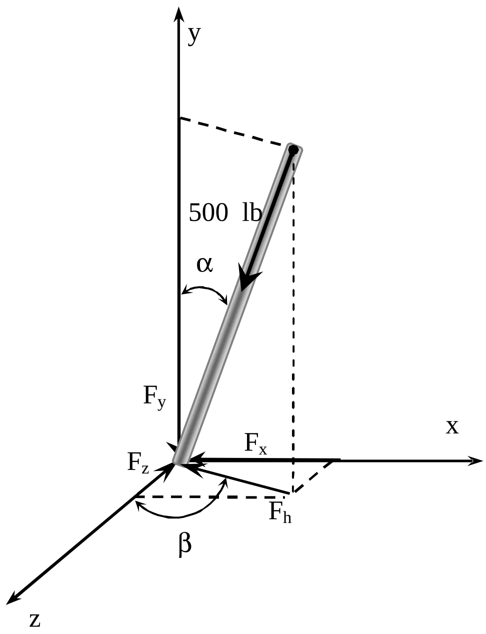
$F_z = F_h\cos\beta = -287\cos 65°$

$F_z = -121.2 lb$

$\theta_x = \cos^{-1}\frac{F_x}{F} = \cos^{-1}\frac{-260}{500} = +121.3°$

$\theta_y = \cos^{-1}\frac{F_y}{F} = \cos^{-1}\frac{410}{500} = +145°$

$\theta_z = \cos^{-1}\frac{F_z}{F} = \cos^{-1}\frac{-121.3}{500} = 104.0°$



2.56 A precast concrete wall section is temporarily held by the cables shown. If the tension in cable *AB* is 700 lb, determine the components of the force exerted on the wall section at *A*.

$d_x = x_B - x_A = 12 - 0$

$d_x = 12$

$d_y = y_B - y_A = 0 - 6$

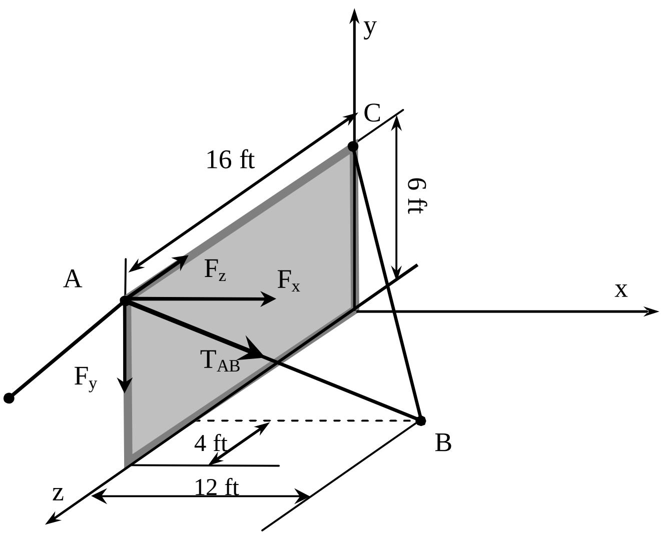
$d_y = -6$

$d_z = z_B - z_A = 12 - 16$

$= -4$

$d = \sqrt{d_x^2 + d_y^2 + d_z^2} = \sqrt{(12)^2 + (-6)^2 + (-4)^2}$

$d = 14$

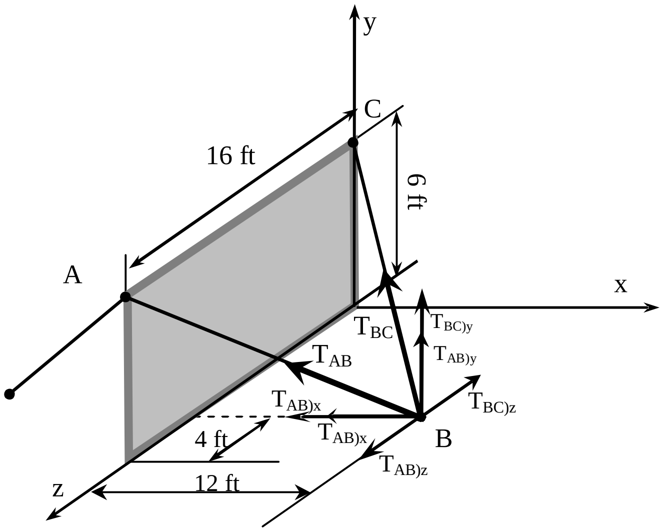


$F_x = \frac{d_x}{d}F = \frac{12}{14}*700 = 600 lb$

$F_y = \frac{d_y}{d}F = \frac{-6}{14}*700 = -300 lb$

$F_z = \frac{d_z}{d}F = \frac{-4}{14}*700 = -200 lb$

2.62 A precast concrete wall section is temporarily held by the cables shown. If the tension in cable *AB* is 700 lb and the tension in cable *BC* is 900 lb , determine the components of the resultant of the forces exerted by the cables on point *B*.



$A\,(0\;,0\;,16)$
$B\,(12\,,0\;,12)$
$C\,(0\;,16\,,0)$

Force (lb)	Distance Components			Distance	Force Components		
	d_x	d_y	d_z	$d=\sqrt{d_x^2+d_y^2+d_z^2}$	$F_x=\frac{d_x}{d}F$	$F_y=\frac{d_y}{d}F$	$F_z=\frac{d_z}{d}F$
T_{AB}= 700	x_A-x_B $=0-12$ $=-12$	y_A-y_B $=6-0$ $=6$	$=z_A-z_B$ $=16-12$ $=4$	$\sqrt{(-12)^2+(6)^2+(4)^2}$ $=14$	$=\frac{d_x}{d}T_{AB}$ $=\frac{-12}{14}*700$ $=-600lb$	$=\frac{d_y}{d}T_{AB}$ $=\frac{6}{14}*700$ $=300lb$	$=\frac{d_z}{d}T_{AB}$ $=\frac{4}{14}*700$ $=200lb$
T_{BC}= 900	x_C-x_B $=0-12$ $=-12$	y_C-y_B $=6-0$ $=6$	$=z_C-z_B$ $=0-12$ $=-12$	$\sqrt{(-12)^2+(6)^2+(-12)^2}$ $=18$	$=\frac{d_x}{d}T_{BC}$ $=\frac{-12}{18}*900$ $=-600lb$	$=\frac{d_y}{d}T_{BC}$ $=\frac{6}{18}*900$ $=300lb$	$=\frac{d_z}{d}T_{BC}$ $=\frac{-12}{18}*900$ $=-600lb$
					$R_x=\Sigma F_x$ $=-1200$	$R_y=\Sigma F_y$ $=600$	$R_z=\Sigma F_z$ $=-400$

$$R_x=\Sigma F_x=-600-600=-1200lb$$

$$R_y=\Sigma F_y=300+300=600\,lb$$

$$R_z=\Sigma F_z=200-600=-400lb$$

$$R=\sqrt{R_x^2+R_y^2+R_z^2}=\sqrt{(-1200)^2+(600)^2+(-400)^2}=1400lb$$

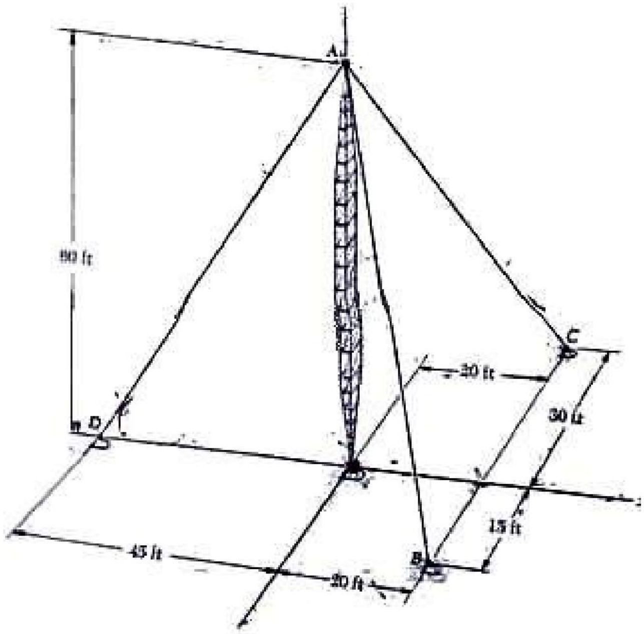
$$\theta_x=\cos^{-1}\frac{R_x}{R}=\cos^{-1}\frac{-1200}{1400}=149^\circ$$

$$\theta_y=\cos^{-1}\frac{R_y}{R}=\cos^{-1}\frac{600}{1400}=64.6^\circ$$

$$\theta_z=\cos^{-1}\frac{R_z}{R}=\cos^{-1}\frac{-400}{1400}=106.6^\circ$$

2.64 Knowing that the tension in *AC* is 7,000 lb , determine the required values of the tension in *AB* and *AD* so that the resultant of the three forces applied at *A* is vertical .

$A(0\ ,60\ ,\ 0\ )$; $B(\ 20\ ,0\ ,15\ )$
$C(\ 20\ ,0\ \ ,-30\ )$; $D(-45\ ,0\ ,\ \ 0\ )$



Force (lb)	Distance Components			Distance	Force Components		
	d_x	d_y	d_z	$d=\sqrt{d_x^2+d_y^2+d_z^2}$	$F_x=\frac{d_x}{d}F$	$F_y=\frac{d_y}{d}F$	$F_z=\frac{d_z}{d}F$
T_{AB}	x_B-x_A $=20-0$ $=20$	y_B-y_A $=0-60$ $=-60$	$=z_B-z_A$ $=15-0$ $=15$	$\sqrt{(20)^2+(-60)^2+(15)^2}$ $=65$	$=\frac{d_x}{d}T_{AB}$ $=\frac{20}{65}T_{AB}$ $=0.3077T_{AB}$	$=\frac{d_y}{d}T_{AB}$ $=\frac{-60}{65}T_{AB}$ $=-0.923T_{AB}$	$=\frac{d_z}{d}T_{AB}$ $=\frac{15}{65}T_{AB}$ $=0.2307T_{AB}$
T_{AC} $=$ 7000	x_C-x_A $=20-0$ $=20$	y_C-y_A $=0-60$ $=-60$	$=z_C-z_A$ $=-30-0$ $=-30$	$\sqrt{(20)^2+(-60)^2+(-30)^2}$ $=70$	$=\frac{d_x}{d}T_{AC}$ $=\frac{20}{70}*7000$ $=2000$	$=\frac{d_y}{d}T_{AC}$ $=\frac{-60}{70}*7000$ $=-6000$	$=\frac{d_z}{d}T_{AC}$ $=\frac{-30}{70}*7000$ $=-3000$
T_{AD}	x_D-x_A $=-45-0$ $=-45$	y_D-y_A $=0-60$ $=-60$	$=z_D-z_A$ $=0-0$ $=0$	$\sqrt{(-45)^2+(-60)^2+(0)^2}$ $=75$	$=\frac{d_x}{d}T_{AD}$ $=\frac{-45}{75}T_{AD}$ $=-0.6T_{AD}$	$=\frac{d_y}{d}T_{AD}$ $=\frac{-60}{75}T_{AD}$ $=-0.8T_{AD}$	$=\frac{d_z}{d}T_{AD}$ $=\frac{0}{75}T_{AD}$ $=0$
					$R_x=\Sigma F_x$	$R_y=\Sigma F_y$	$R_z=\Sigma F_z$

$$R_x=\Sigma F_x=0\Rightarrow 0.3077T_{AB}+2000-0.6T_{AD}=0 \qquad \text{.........................(1)}$$

$$R=R_y=\Sigma F_y=0\Rightarrow -0.923\,T_{AB}-6000-0.8T_{AD} \qquad \text{.......... ......(2)}$$

$$R_z=\Sigma F_z=0\Rightarrow 0.230T_{AB}-3000=0\Rightarrow T_{AB}=\frac{3000}{0.23}=13043.47lb$$

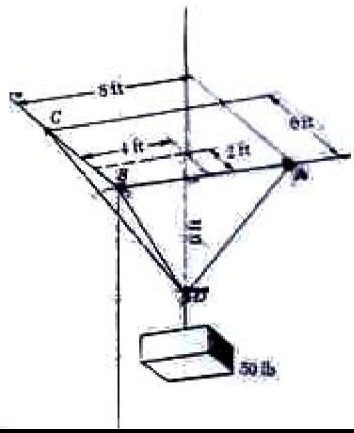
From (1) $0.3077(13043.47)+2000-0.6T_{AD}=0\Rightarrow T_{AD}=10024.51lb$

From (2) $R=R_y=\Sigma F_y=0\Rightarrow -0.923(13043.47)-6000-0.8(10024.510)$

$R=-20058.73lb$

....

2.70 A 50-lb load is supported by three ropes which are attached to a ceiling as shown. Determine the tension in each rope.



$A\,(8,0,0)$; $B\,(0,0,0)$
$C\,(0,0,6)$; $D\,(4,-6,2)$

Force (lb)	Distance Components			Distance	Force Components		
	d_x	d_y	d_z	$d=\sqrt{d_x^2+d_y^2+d_z^2}$	$F_x=\frac{d_x}{d}F$	$F_y=\frac{d_y}{d}F$	$F_z=\frac{d_z}{d}F$
T_{AD}	x_A-x_D $=8-4$ $=4$	y_A-y_D $=0-(-6)$ $=6$	$=z_A-z_D$ $=0-2$ $=-2$	$\sqrt{(4)^2+(6)^2+(-2)^2}$ $=7.4833$	$=\frac{d_x}{d}T_{AD}$ $=\frac{4}{7.4833}T_{AD}$ $=0.534T_{AD}$	$=\frac{d_y}{d}T_{AD}$ $=\frac{6}{7.4833}T_{AD}$ $=0.801T_{AD}$	$=\frac{d_z}{d}T_{AD}$ $=\frac{-2}{7.4833}T_{AD}$ $=-0.267T_{AD}$
T_{BD}	x_B-x_D $=0-4$ $=-4$	y_B-y_D $=0-(-6)$ $=6$	$=z_B-z_D$ $=0-2$ $=-2$	$\sqrt{(-4)^2+(6)^2+(-2)^2}$ $=7.4833$	$=\frac{d_x}{d}T_{BD}$ $=\frac{-4}{7.4833}T_{BD}$ $=-0.534T_{BD}$	$=\frac{d_y}{d}T_{BD}$ $=\frac{6}{7.4833}T_{BD}$ $=0.801T_{BD}$	$=\frac{d_z}{d}T_{BD}$ $=\frac{-2}{7.4833}T_{BD}$ $=-0.267T_{BD}$
T_{CD}	x_C-x_D $=0-4$ $=-4$	y_C-y_D $=0-(-6)$ $=6$	$=z_C-z_D$ $=6-2$ $=4$	$\sqrt{(-4)^2+(6)^2+(4)^2}$ $=8.246$	$=\frac{d_x}{d}T_{CD}$ $=\frac{-4}{8.246}T_{CD}$ $=-0.485T_{CD}$	$=\frac{d_y}{d}T_{CD}$ $=\frac{6}{8.246}T_{CD}$ $=0.727T_{CD}$	$=\frac{d_z}{d}T_{CD}$ $=\frac{4}{8.246}T_{CD}$ $=0.485T_{CD}$
50	-	-	-	-	-	-50	-
					$R_x=\Sigma F_x$	$R_y=\Sigma F_y$	$R_z=\Sigma F_z$

$$R_x=\Sigma F_x=0\Rightarrow 0.534T_{AD}+0.534T_{BD}-0.485T_{CD}=0$$

$$0.485T_{CD}=0.534(T_{AD}-T_{BD})\Rightarrow T_{CD}=1.1(T_{AD}-T_{BD})\ldots\ldots\ldots\ldots(1)$$

$$R_y=\Sigma F_y=0\Rightarrow 0.801T_{AD}+0.801T_{BD}+0.727T_{CD}-50=0$$

$$0.801T_{AD}+0.801T_{BD}+0.727(1.1(T_{AD}-T_{BD}))-50=0$$

$$1.6007T_{AD}+0.0013T_{BD}-50=0\Rightarrow T_{AD}=31.236-0.000812T_{BD}\ldots\ldots(2)$$

$$R_z=\Sigma F_z=0\Rightarrow 0.267T_{AD}-0.267T_{BD}+0.485T_{CD}=0$$

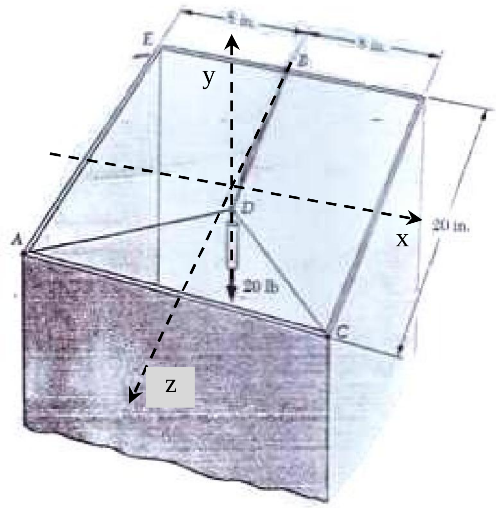
$$-0.267(31.236-0.000812T_{BD})-0.267T_{BD}+0.485(1.1(31.236$$
$$-0.000812T_{BD}-T_{BD}))=0$$

$$=-8.34+0.000216T_{BD}-0.267T_{BD}+16.6644-0.53393T_{BD}=0$$

$$=-0.8007T_{BD}+8.3244=0\Rightarrow T_{BD}=10.3964\ lb$$

$$,.T_{AD}=31.22755\ lb,.T_{CD}=22.914\ lb$$

2.75 A 20-lb instrument is hung inside a box by means of three strings. If the instrument hangs directly in the center of the box and the strings are tied together at a point *D*, 3 in. below the top of the box, determine the tension in each sting.



A (-8 , 0 , 10) ; *B* (0 , 0 , -10)
C (8 , 0 , 10) ; *D* (0 , -3 , 0)

Force (lb)	Distance Components d_x	d_y	d_z	Distance $d=\sqrt{d_x^2+d_y^2+d_z^2}$	Force Components $F_x=\frac{d_x}{d}F$	$F_y=\frac{d_y}{d}F$	$F_z=\frac{d_z}{d}F$
T_{AD}	x_A-x_D $=-8-0$ $=-8$	y_A-y_D $=0-(-3)$ $=3$	$=z_A-z_D$ $=10-0$ $=10$	$\sqrt{(-8)^2+(3)^2+(10)^2}$ $=13.1529$	$=\frac{d_x}{d}T_{AD}$ $=\frac{-8}{13.1529}T_{AD}$ $=-0.608T_{AD}$	$=\frac{d_y}{d}T_{AD}$ $=\frac{3}{13.1529}T_{AD}$ $=0.228T_{AD}$	$=\frac{d_z}{d}T_{AD}$ $=\frac{10}{13.1529}T_{AD}$ $=0.76T_{AD}$
T_{BD}	x_B-x_D $=0-0$ $=0$	y_B-y_D $=0-(-3)$ $=3$	$=z_B-z_D$ $=-10-0$ $=-10$	$\sqrt{(0)^2+(3)^2+(-10)^2}$ $=10.44$	$=\frac{d_x}{d}T_{BD}$ $=\frac{0}{10.44}T_{BD}$ $=0$	$=\frac{d_y}{d}T_{BD}$ $=\frac{3}{10.44}T_{BD}$ $=0.287T_{BD}$	$=\frac{d_z}{d}T_{BD}$ $=\frac{-2}{7.4833}T_{BD}$ $=-0.9578T_{BD}$
T_{CD}	x_C-x_D $=8-0$ $=8$	y_C-y_D $=0-(-3)$ $=3$	$=z_C-z_D$ $=10-0$ $=10$	$\sqrt{(8)^2+(3)^2+(10)^2}$ $=13.1529$	$=\frac{d_x}{d}T_{CD}$ $=\frac{8}{13.1529}T_{CD}$ $=0.608T_{CD}$	$=\frac{d_y}{d}T_{CD}$ $=\frac{3}{13.1529}T_{CD}$ $=0228T_{CD}$	$=\frac{d_z}{d}T_{CD}$ $=\frac{10}{13.1529}T_{CD}$ $=0.76T_{CD}$
W	-	-	-	-	-	-20	-
					$R_x=\Sigma F_x$	$R_y=\Sigma F_y$	$R_z=\Sigma F_z$

$$R_x=\Sigma F_x=0\Rightarrow -0.608T_{AD}+0.608T_{CD}=0\Rightarrow T_{AD}=T_{CD}\ldots\ldots\ldots(1)$$

$$R_y=\Sigma F_y=0\Rightarrow 0.228T_{AD}+0.287T_{BD}+0.228T_{CD}-20=0$$

$$0.456T_{AD}+0.287T_{BD}-20=0\Rightarrow T_{AD}=43.859-0.629T_{BD}\ldots\ldots\ldots\ldots(2)$$

$$R_z=\Sigma F_z=0\Rightarrow 0.76T_{AD}-0.9578T_{BD}+0.76T_{CD}=0$$

$$1.52T_{AD}-0.9578T_{BD}=0\Rightarrow 1.52(43.859-0.629T_{BD})-0.9578T_{BD}=0$$

$$66.6656-0.956T_{BD}-0.9578T_{BD}\Rightarrow T_{BD}=34.8326lb$$

$$T_{AD}=21.949lb$$

$$T_{CD}=21.949lb$$