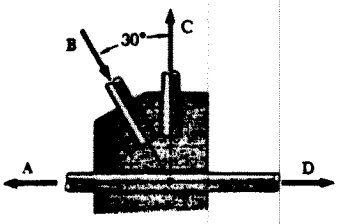
Examples

#6

Equilibrium of a Particle
(2-D : Coplanar Forces)

Example 1:



Given:

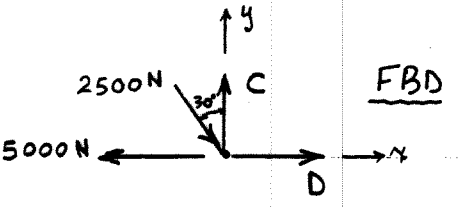
The forces on the connection shown

$A = 5000$ N , $B = 2500$ N

The connection is in equilibrium.

Req.d:

The forces C and D



Soln.:

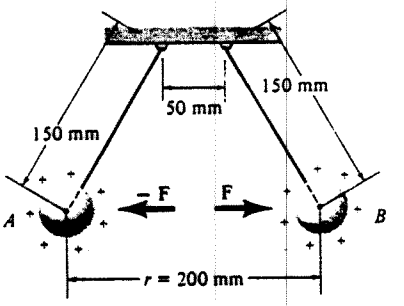
Equilibrium ⇒ From the FBD

$\pm\rightarrow \Sigma F_x = 0 \Rightarrow -5000 + D + 2500 \sin 30^\circ = 0 \Rightarrow$ **$D = 3750$ N**

$+\uparrow \Sigma F_y = 0 \Rightarrow C - 2500 \cos 30^\circ = 0 \Rightarrow$ **$C = 2165$ N**

* Note: 2 equations & 2 unknowns

Example 2:



Given:

The electrically charged balls shown

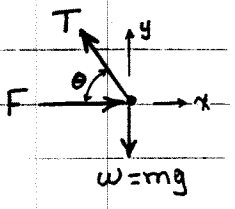
$m = 0.2$ g each

Req.d:

The resultant horizontal force of repulsion F

Soln.:

FBD



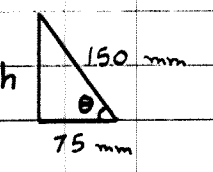
From the FBD, it is easier to start with $\Sigma F_y = 0$. (Why?)

$\Sigma F_y = 0 \Rightarrow$

$T \sin\theta - mg = 0$

$T\,(129.9/150) - 0.2\,(10)^{-3}(9.81) = 0$

$\Rightarrow T = 2.266\,(10)^{-3}$ N $= 2.266$ mN



$h = \sqrt{(150)^2 - (75)^2}$

$= 129.9$ mm

$\Sigma F_x = 0 \Rightarrow$

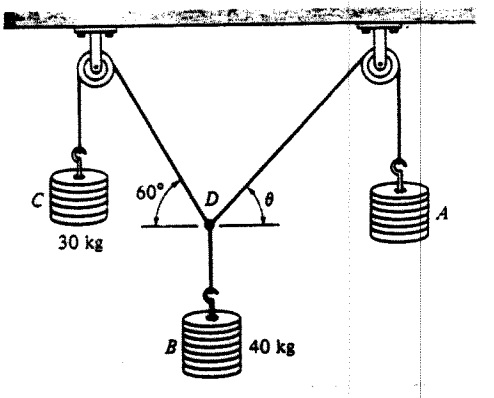
$F - T\cos\theta = 0$

$F - 2.266\,(75/150) = 0$

$\Rightarrow$ **$F = 1.13$ mN**

#6

Example 3:



Given:

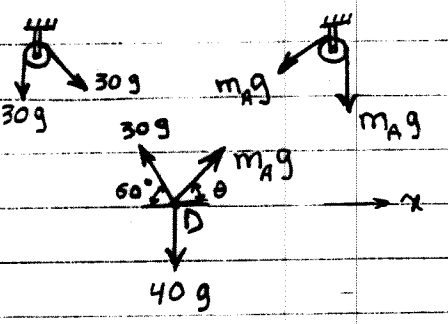
The system shown which is in equilibrium

Req'd.:

The mass at A and the angle θ

Soln.:

From the FBD shown, D is in equilibrium



$\Rightarrow \Sigma F_x = 0 \Rightarrow m_A g \cos\theta - 30g \cos 60^\circ = 0$

$\Sigma F_y = 0 \Rightarrow m_A g \sin\theta + 30g \sin 60 - 40g = 0$

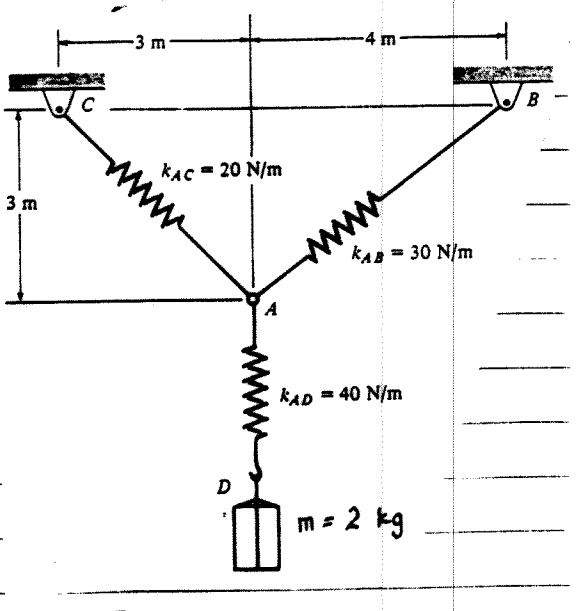
$\Rightarrow m_A = 15/\cos\theta$

$\Rightarrow 15 \tan\theta + 30 \sin 60^\circ - 40 = 0$

$\Rightarrow \boxed{\theta = 43.1^\circ} \Rightarrow m_A = \frac{15}{\cos 43.1} \Rightarrow \boxed{m_A = 20.5 \text{ kg}}$

Notes: ① $W = mg$; ② pulleys are assumed frictionless (smooth).

Example 4:



Given:

The springs shown in the figure which are in their equilibrium position

Req'd.:

The stretch in each spring

Soln.: ((First, guess the answers!))

From the FBD, $\Sigma F_x = 0 \Rightarrow$

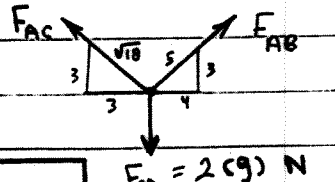
$F_{AB}\left(\frac{4}{5}\right) - F_{AC}\left(\frac{3}{\sqrt{18}}\right) = 0 \Rightarrow F_{AC} = 1.1314\, F_{AB}$

$\Sigma F_y = 0 \Rightarrow$

$-2g + F_{AB}\left(\frac{3}{5}\right) + F_{AC}\left(\frac{3}{\sqrt{18}}\right) = 0$

$\frac{3}{5} F_{AB} + 1.1314\left(\frac{3}{\sqrt{18}}\right) F_{AB} = 2g \Rightarrow F_{AB} = 14.01 \text{ N}$

$\Rightarrow F_{AC} = 1.1314\,(14.01) = 15.86 \text{ N}$



$F_{AD} = 2(g)$ N

$F_{spring} = ks \Rightarrow s = F/k \Rightarrow s_{AB} = \frac{14.01}{30} \Rightarrow \boxed{s_{AB} = 0.467 \text{ m}}$

$s_{AC} = \frac{15.86}{20} \Rightarrow \boxed{s_{AC} = 0.793 \text{ m}}$ $\quad s_{AD} = \frac{2(9.81)}{40} \Rightarrow \boxed{s_{AD} = 0.491 \text{ m}}$

Answers as expected?!