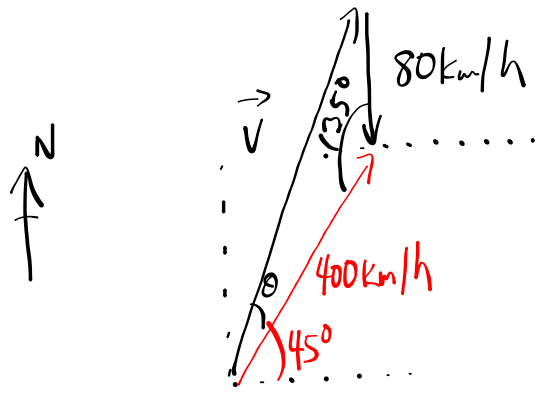
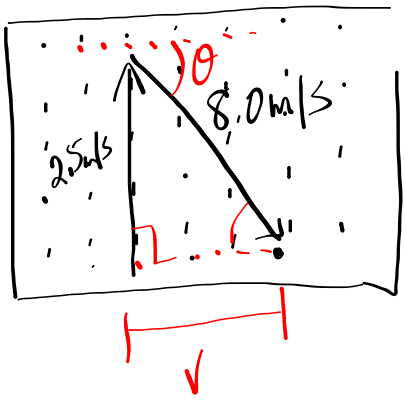
# Relative Motion Sheet

3.

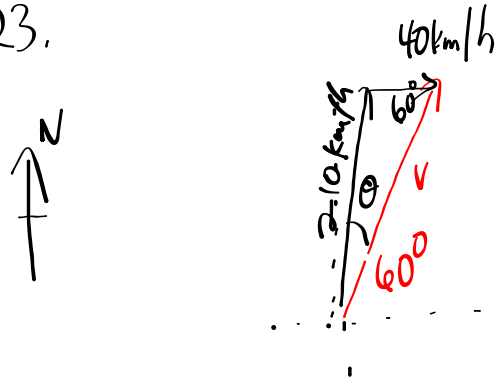



4.




## PP|110

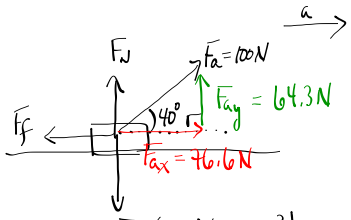
23.



# Forces at Angles

SP

Side view FBD




$\cos 40° = \frac{F_{ax}}{100N}$

$F_{ax} = (100N)(\cos 40°)$

$F_{ax} = 76.6N$

$F_g = (20kg)(9.81 m/s^2)$

$F_g = 196.2N$

$\sin 40° = \frac{F_{ay}}{100N}$

$F_{ay} = (100N)\sin 40°$

$F_{ay} = 64.3N$

$\vec{F}_{net} = m\vec{a}$ (Newton's Second Law)

**Horizontally**

$F_{net} = ma$

$F_{ax} - F_f = ma$

$F_{ax} - \mu F_N = ma$

**Vertically**

$F_{net} = 0$

$F_N + F_{ay} = F_g$

$F_N = F_g - F_{ay}$

$F_{ax} - \mu(F_g - F_{ay}) = ma$

$76.6N - 0.32(196.2N - 64.3N) = (20kg)a$

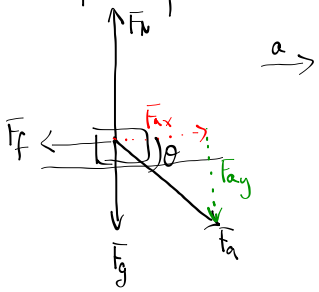
$76.6N - 0.32(131.9) = (20kg)a$

$76.6N - 42.208N = (20kg)a$

$34.392N = (20kg)a$

$a = 1.7 m/s^2$

What if you are pushing down at angle?




Pulling up at an angle decreases $F_N$ $(F_N < F_g)$

Pushing down at an angle increases $F_N$ $(F_N > F_a)$

# A 3-Way Tug-of-War

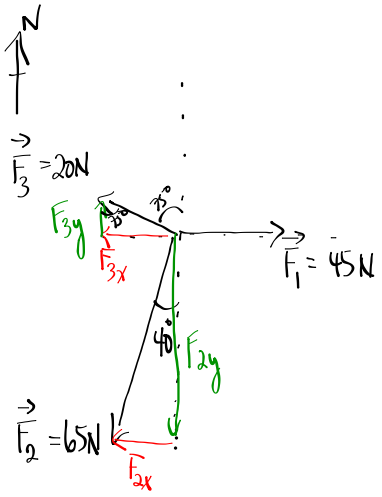
MP/464

$\vec{F}_1 = 45N\ [E]$

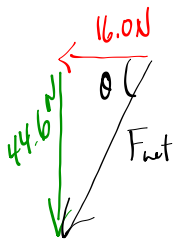
$\vec{F}_2 = 65N\ [S40°W]$

$\vec{F}_3 = 20N\ [N75°W]$

FBD → bird's eye view




| | x | y |
|---|---|---|
| $F_1$ | 45N | 0 |
| $F_2$ | $-(65N)\sin 40°$ $-41.78N$ | $-(65N)\cos 40°$ $-49.79N$ |
| $F_3$ | $-(20N)\sin 75°$ $-19.23N$ | $+(20N)\cos 75°$ $+5.18N$ |
| $F_{net}$ | $-16.01N$ | $-44.6N$ |




$c^2 = a^2 + b^2$

$c^2 = (44.6)^2 + (16.01)^2$

$c = 47N$

$\tan\theta = \frac{44.6}{16.01}$

$\theta = 70°$

$\vec{F}_{net} = 47N\ [W70°S]$

$\vec{a} = \frac{\vec{F}_{net}}{m}$

$\vec{a} = \frac{47N\ [W70°S]}{65kg}$

$\vec{a} = 0.72\ m/s^2\ [W70°S]$