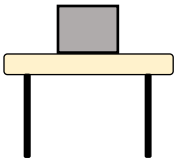
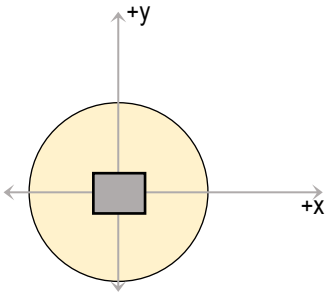
CONCEPT: 2D FORCES IN HORIZONTAL PLANE

EXAMPLE: A 5kg block on a circular tabletop is pulled by 2 horizontal forces. If F_1 = 2N along +x-axis and F_2 = 5N at 37°, find **(a)** $\vec{F}_{net}$, **(b)** a_x, **(c)** a_y, **(d) a.**

Side View



Top View



2D FORCES
1) Draw FBD: **W,F_A,T,N,f**
2) Decompose 2D Forces
3) Write $\boldsymbol{\Sigma F = ma}$ in x & y
4) Solve

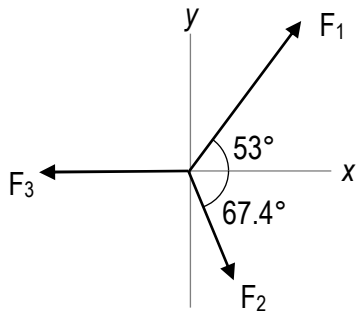
	x	y
$\vec{F}_1$		
$\vec{F}_2$		
$\vec{F}_{net}$ = _____		

- IF applied forces act only in the horizontal plane, N = ____
  - $\Sigma F_{vert} = 0$ (in the side view), so vertical forces (weight, Normal) aren't important.
- Because Forces = vectors, when a Force acts at an angle in 2D, we must _____ it into its **x** & **y** components.
  - If multiple forces acting, F_{net} is always calculated using _____.

PROBLEM**:** Three horizontal forces act on a box (mass = 8 kg) sitting on a smooth surface. $\mathbf{F}_1$ is 30 N acting at 53° counterclockwise from the +x axis, $\mathbf{F}_2$ is 13 N acting at 67.4° clockwise from the +x axis, and $\mathbf{F}_3$ is 20 N directly along the -x axis. What are the magnitude and direction of the box's acceleration?

A) 1.5 m/s^2, 14° ccw from +x-axis
B) 1.5 m/s^2, 76° ccw from +x-axis
C) 6.9 m/s^2, 1.1° cw from -x-axis
D) 6.9 m/s^2, 0.46° cw from -x-axis

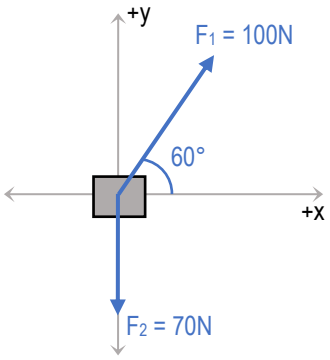
2D FORCES
1) Draw FBD
2) Write $\boldsymbol{\Sigma F = ma}$ in x & y
3) Solve



CONCEPT: SOLVING AN UNKNOWN 2D FORCE

- In some problems, you'll have to solve for a Force *without* knowing its magnitude **OR** direction from the problem.
  - When expanding **ΣF=ma** in X&Y, assume the components of unknown forces are _____.

EXAMPLE: Three horizontal forces pull a 40kg block. F_1 = 100N at 60° above the +x-axis, F_2 = 70N along the -y axis. Find the magnitude of the third force required so that the block accelerates at 2m/s^2 *only* along the x-axis.



	x	y
$\vec{F}_1$		
$\vec{F}_2$		
$\vec{F}_{net}$ = _____		

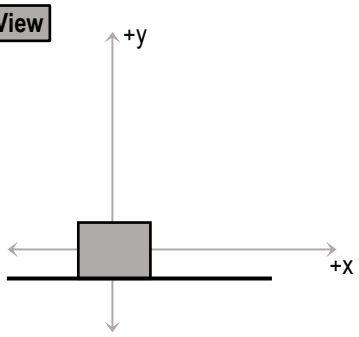
2D FORCES

1) Draw FBD: **W,F_A,T,N,f**
2) Decompose 2D Forces
3) Write $\Sigma F = ma$ in x & y
4) Solve

CONCEPT: 2D FORCES IN HORIZONTAL & VERTICAL PLANES

EXAMPLE: A 5.1kg block on the floor is pulled by a 10N force 37° above the horizontal. Assuming no friction, find **(a)** the Normal force on the block; **(b)** the block's acceleration.

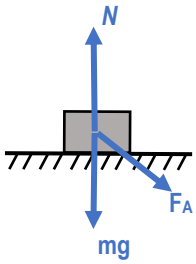
Side View **Top View**



2D FORCES
1) Draw FBD: **W,F_A,T,N,f**
2) Decompose 2D Forces
3) Write $\Sigma F = ma$ in x & y
4) Solve

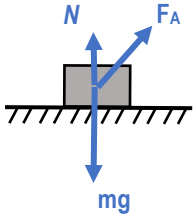
● IF applied forces act partially/completely vertically, then N _____.

- In most problems, $F_{up} < F_{down}$, so the object is in equilibrium in the y-axis: $\Sigma F_y = 0 \Leftrightarrow a_y = 0$



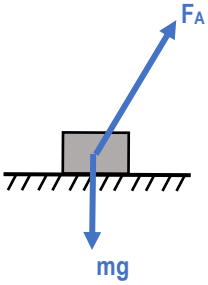
- Push down

N ***mg***



- Pull up, not enough to lift ($F_{up} < F_{down}$)

N ***mg***



- Pull up, enough to lift ($F_{up} > F_{down}$)

N

PROBLEM**:** You push a 5.1kg cart along the floor with an unknown force **F** at 30° below the horizontal**.** Using a scale, you know the Normal force is 70N**.** What is the horizontal acceleration of the cart?

A) 7.84 m/s^2
B) 3.92 m/s^2
C) 6.79 m/s^2
D) 2.26 m/s^2

2D FORCES

1) Draw FBD**: W,F$_A$,T,N,f**
2) Decompose 2D Forces
3) Write $\boldsymbol{\Sigma F = ma}$ in x & y
4) Solve

PROBLEM**:** You drop a 2-kg box straight down from the top of a building**.** A steady horizontal wind exerts a constant force of 3 N on the box as it falls**.** (Ignore other air resistance**.**) What is the direction of the box's acceleration?

A) 1.4° below horizontal
B) 8.7° below horizontal
C) 81° below horizontal
D) 33° below horizontal
E) Not enough information to tell

2D FORCES
1) Draw FBD **2)** Write $\boldsymbol{\Sigma F = ma}$ in x & y **3)** Solve