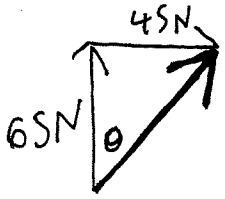
Forces in 2D

EXAMPLE 1: A block is pushed by two people, one towards the North, the other towards to East. The person pushing North pushes with a force of 65 N, the person pushing East pushes with a force of 45 N.

If we ignore friction what is the net force acting on the block?



$\sqrt{45^2 + 65^2}$

$= 79.06N$

$\theta = \tan^{-1}\left(\frac{45N}{65N}\right)$

$= 35^\circ$

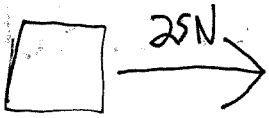
79N, 35° East of North

What is the acceleration of the block if it has mass of 105 kg?

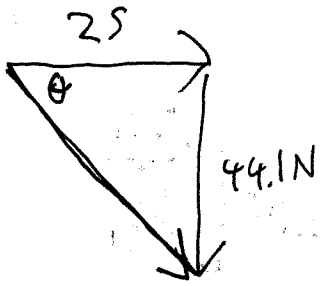
$a = \frac{F_{net}}{m} = \frac{79N}{105kg} = 0.75 m/s^2, 35^\circ$ East of North

EXAMPLE 2: A 4.5 kg rocket is pointed perfectly horizontally, its engine outputs 25 N of force horizontally, gravity pulls the rocket downwards.

If we ignore air resistance what is the net force acting on the rocket?



$F_g = mg = 44.1\,N$



$\sqrt{25^2 + 44.1^2} = 50.69\,N$

$\tan^{-1}\left(\frac{44.1}{25}\right) = 60°$

51N, 60° below the horizontal

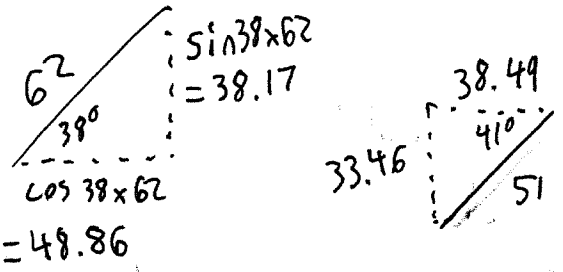
What is the acceleration of the rocket?

$$a = \frac{F_{net}}{m} = \frac{51\,N}{4.5\,kg} = 11.3\,m/s^2$$

6.0×10^{1} degrees below the horizontal

EXAMPLE 3: A 25 kg block is pushed by two forces, a 62 N force at 38° N of E, and a 51 N force at 41° S of W.

What is the net force acting on the block?

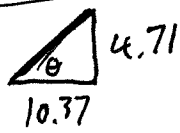


F_{net} East / West

48.86E + 38.49W = 10.37 East

F_{net} North / South

38.17 North + 33.46 South = 4.71 North



$R = \sqrt{4.71^2 + 10.37^2}$

$= 11.39\,N$

$\theta = \tan^{-1}\left(\frac{4.71}{10.37}\right)$

$= 24.24°$

11N, 24° North of East

What is the block's acceleration in the North/South direction?

$$\frac{4.71\,N\ North}{25\,kg}$$

$$= 0.1884\,m/s^2\ North$$

$\approx 0.19\,m/s^2$ North

How long will it take for the block to travel 35 m North?

$a = 0.1884\,m/s^2$

$d = 35\,m$

$v_0 = 0$

Use $d = v_0 t + \frac{1}{2} a t^2$

$t \approx 19\,sec$