Problem solving with Newton

The motion is given

Calculate one or more unknown forces that cause this motion.

Uniform acceleration → $v_x(t) = a_x.t + v_{0x}$, $x(t) = x_0 + v_{0x}.t + \frac{1}{2}a_x.t^2$ → $F_{res} = m.a$

Constant velocity or standing still → $v_x(t) = v_{0x}$, $x(t) = v_{0x}.t + x_0$ → $F_{res} = 0$

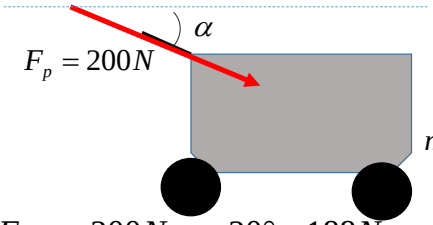
→ $\Sigma F = F_{res}$

Study each axis: x or y

The vectors need to be decomposed with respect to this frame of reference.

Problem solving with Newton

Example: You push a shopping cart with a constant force of 200Nwith an angle of -20° in respect to the ground. The mass of the cart is 45 kg. This will cause the cart to accelerate in 2,0 seconds from 0 to 2,6 m/s. Calculate the frictonal force and the normal force.



With respect to the y-as: no acceleration $F_{res,Y} = 0$

With respect to theX-as: uniform acceleration

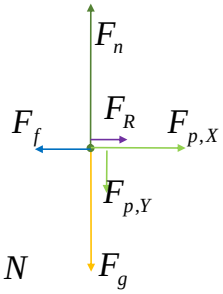
$v_x(t) = a_x.t + v_{0x}$ $\quad a_x = \frac{v_x}{t} = \frac{2{,}6\frac{m}{s}}{2{,}0s} = 1{,}3\frac{m}{s^2}$

$F_{R,X} = 45kg.1{,}3\frac{m}{s^2} = 59N$

$F_{p,X} = 200N.\cos 20° = 188N$

$F_{p,Y} = 200N.\sin 20° = 68N$

$F_g = m.g = 45.9{,}81 = 4{,}4.10^2\,N$



$F_{R,X} = 59N = F_{p,X} - F_f$ $\quad F_f = F_{p,Y} - F_{R,X} = 188 - 59 = 129N$

$F_{R,Y} = 0N = F_g + F_{p,Y} - F_n$ $\quad F_n = F_g + F_{p,Y} = 4{,}4.10^2\,N + 68N = 5{,}1.10^2\,N$

Problem solving with Newton

The forces are given.

Decompose forces with respect to X and Y- axis

$\Sigma F_X = F_{res,X}$

$\Sigma F_Y = F_{res,Y}$

$F_{res} = 0$ Constant velocity or no motion

$v(t) = v_0$

$x(t) = v_0.t + x_0$

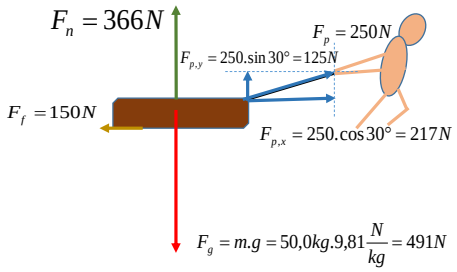
$F_{res} = m.a$ Uniform acceleration

$v(t) = a.t + v_0$

$x(t) = x_0 + v_0.t + \frac{1}{2}a.t^2$

Problem solving with Newton

Example: You pull the sleigh and on the sleigh is your little sister. You exert a force of 250 Newton with an angle of 30,0° in respect to the X-axis. The sleigh's mass together with your sister is 50,0 kg. The frictional force is 150N en the normal force is 366N. If you pull during 2,0 seconds, what speed will you obtain if your initial velocity was 0.



Forces along Y-axis:

$F_{res,Y} = F_n + F_{p,Y} - F_g = 366 + 125 - 491 = 0$

Forces along X-axis:

$F_{res,X} = F_{p,X} - F_f = 217 - 150 = 67N$

$F_{res,X} = m.a_x$ $\quad a_x = \frac{F}{m} = \frac{67N}{50{,}0kg} = 1{,}3\frac{m}{s^2}$

$v_x(t) = a_x.t + v_{0x}$ $\quad v_x(t) = 1{,}3.2{,}0 + 0 = 2{,}6\frac{m}{s}$