Problem Solving

Summary:

If an object is at rest or moving with a constant velocity, forces are balanced, $\vec{a} = 0\ \frac{m}{s^2}$ and $\Sigma\vec{F} = 0$

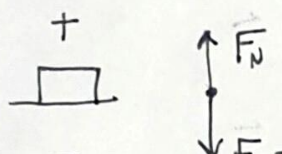
If an object is accelerating, forces are not balanced, $\Sigma\vec{F}$ (net force) causes $\vec{a}$ (acceleration)

Problem Solving Process/Format:

1. Draw Picture, define + and − direction
2. Draw FBD
3. Write the equation $\Sigma\vec{F} = m\vec{a}$ and plug in the forces from your FBD
4. Decide if $\vec{a} = 0$ or not
5. Use algebra to solve for desired variable

<u>Problems with gravity and the normal force</u>

Ex 1) A 10.0 kg box sits at rest on the table. How large is the normal force on the box?



$F_g = mg$

$= (10\ kg)(9.8\ \frac{m}{s^2})$

$= 98N$

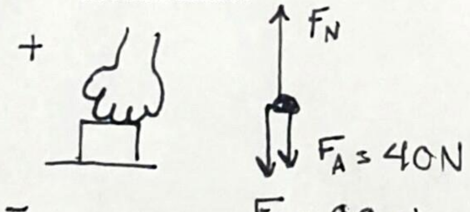
$\Sigma\vec{F} = m\vec{a}$

$+F_N - F_g = m\vec{a} \to 0$ (balanced forces)

$F_N - 98N = 0$

$\boxed{F_N = 98N}$

Ex 2) If you push DOWN on the box with a 40.0 N force, now how large is the normal force?



$\Sigma\vec{F} = m\vec{a}$

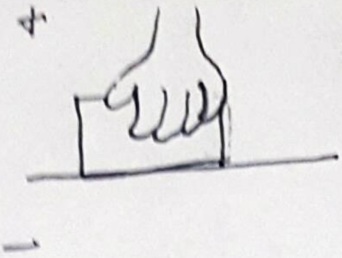
$+F_N - F_A - F_g = m\vec{a} \to 0$ (balanced forces)

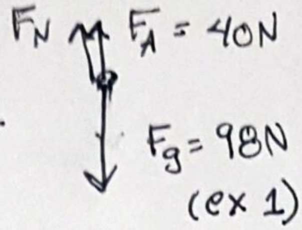
$F_N - 40N - 98N = 0$

$\boxed{F_N = 138N}$

* Normal Force can change!

Ex 3) If you pull UP on the box with 40.0 N, how large is the normal force?





$\Sigma \vec{F} = m\vec{a}$

$+F_N + F_A - F_g = m\vec{a} \rightarrow 0$

$F_N + 40N - 98N = 0$

$F_N = 58N$

Ex 4) What happens if you pull UP on the box with 100.0 N?

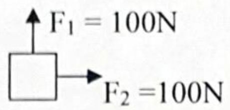
$F_N + F_A > F_g$

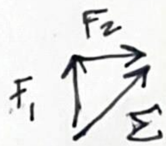
unbalanced forces, box accelerates up

Solving Force Problems Involving Angled Vectors

Net force is a VECTOR sum…

What is the net force on the box (viewed from above)? Assume no friction.



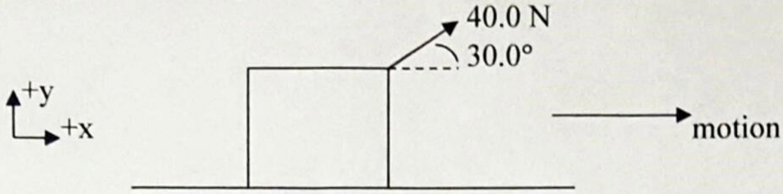


$\Sigma \vec{F} = \vec{F_1} + \vec{F_2}$

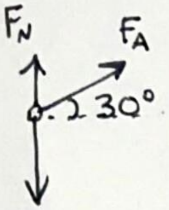
$\Sigma \vec{F} = \sqrt{F_1^2 + F_2^2}$

$\Sigma F = 100\sqrt{2}$ N

Ex 3) Suppose a 10.0 kg box is pulled on with a rope as shown below.



a) What is the acceleration of the box? (assume no friction)



Angled Force = hypotenuse

"COMPONENTS" = legs

SOH-CAH-TOA

$\sin(30°) = \frac{F_{Ay}}{40N}$

$F_{Ay} = 20N$

$F_g = mg = 98N$

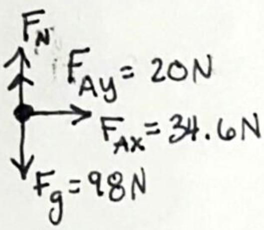
$F_{Ax} = 34.6N$

$F_{Ay} = 20N$

$\cos(30°) = \frac{F_{Ax}}{40N}$

$F_{Ax} = 34.6N$

Replace F_A with its components



$\Sigma \vec{F}_x = m\vec{a}_x$

$F_{Ax} = (10\,kg)a_x$

$34.6N = 10\,kg\;a$

$a = 3.46\,\frac{m}{s}$

b) What is the normal force on the box?

$\Sigma F_y = m\cancel{a_y}^{\,0}$

$+F_N + F_{Ay} - F_g = 0$

$F_N + 34.6N - 98N = 0$

$F_N = 78N$ (less than F_g)