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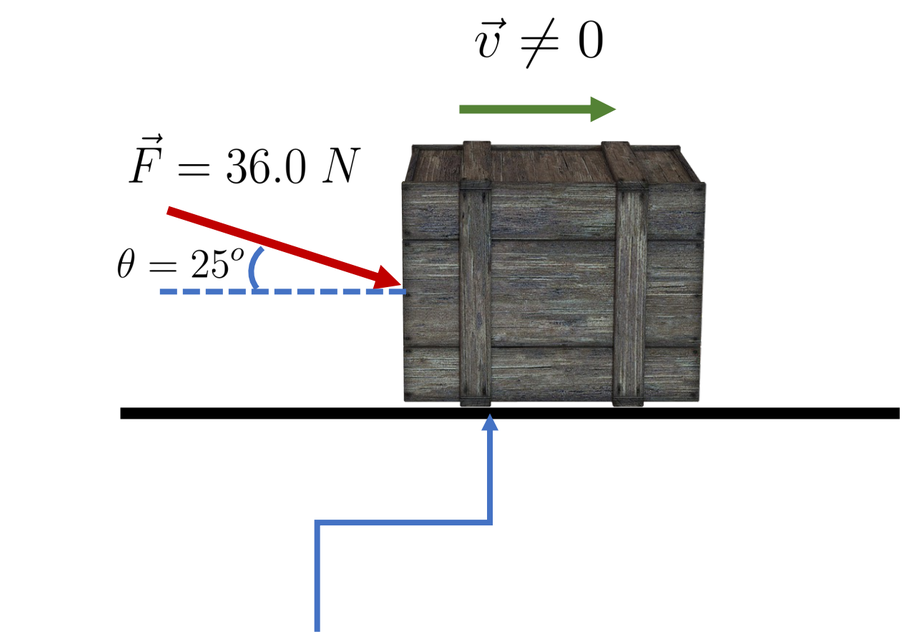
Object Moving on a Floor with friction

A wooden crate, mass 6.00 kg, is being pushed by a force of 36.0 N magnitude as shown below, on a floor with friction coefficient $\mu_k = 0.25$. The crate is already moving with a non-zero velocity. The force makes a 25^0 angle with the horizontal as indicated. Find the crate's acceleration.



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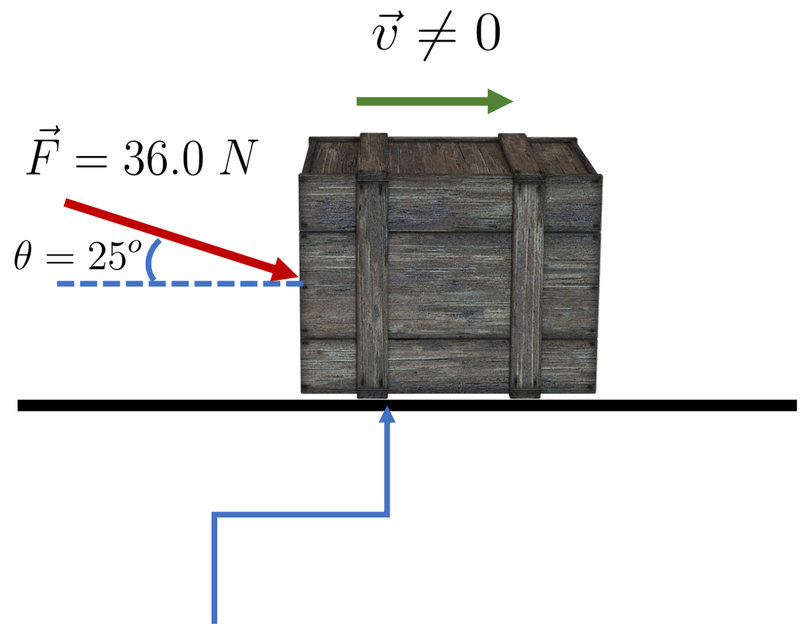
Find the crate's acceleration

$$m_{crate} = 6.00\ kg$$

$$\vec{F} = 36.0\ N$$

$$\theta = 25^o$$

$$\mu_k = 0.25$$



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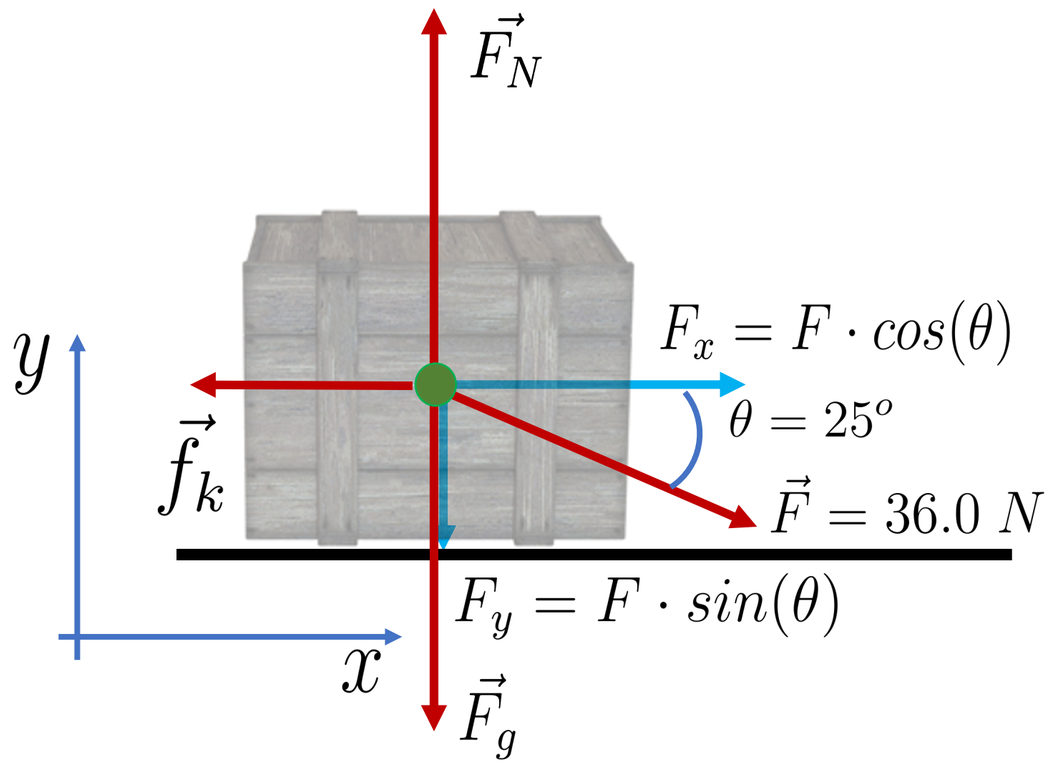
Free Body Diagram (FBD)

$$m_{crate} = 6.00\ kg$$

$$\vec{F} = 36.0\ N$$

$$\theta = 25^o$$

$$\mu_k = 0.25$$



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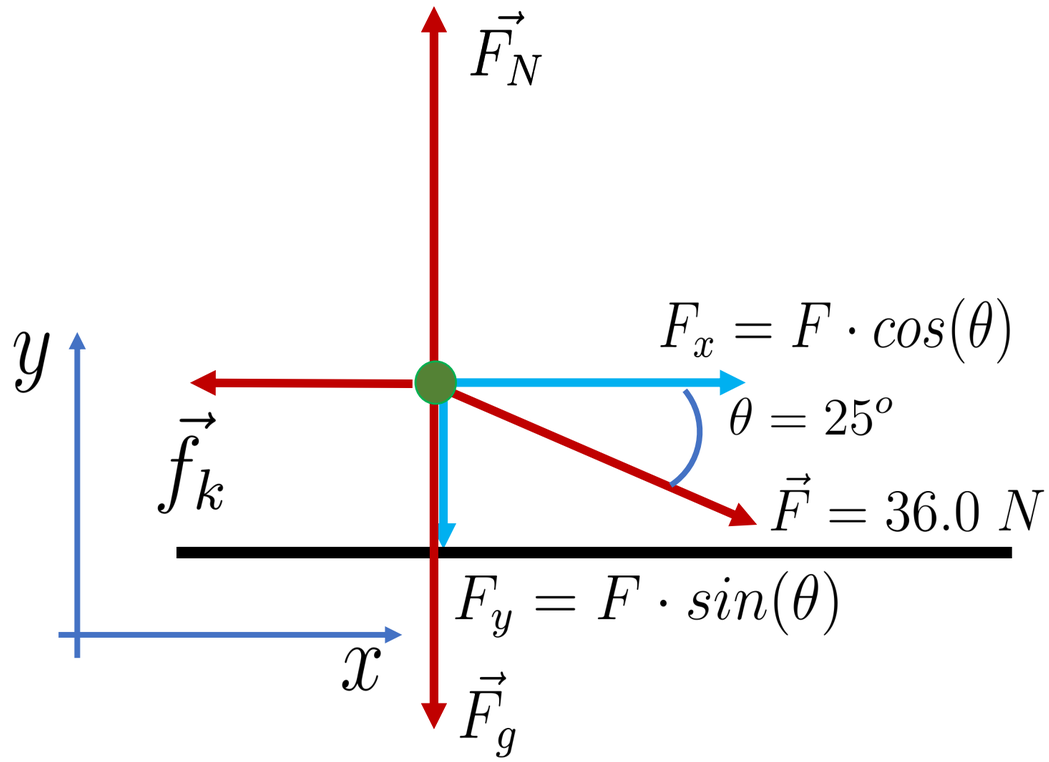
Free Body Diagram (FBD)

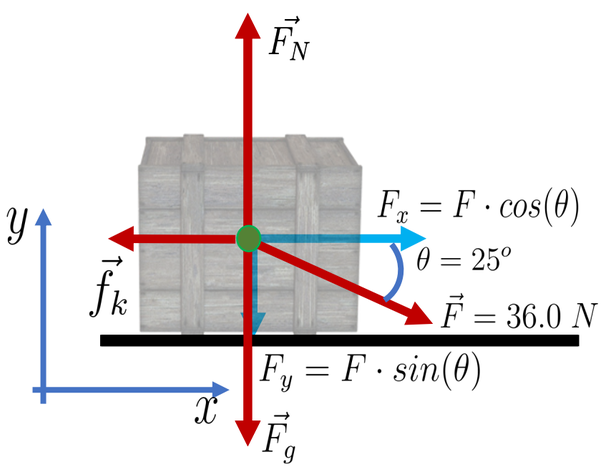
$$m_{crate} = 6.00\ kg$$

$$\vec{F} = 36.0\ N$$

$$\theta = 25^o$$

$$\mu_k = 0.25$$





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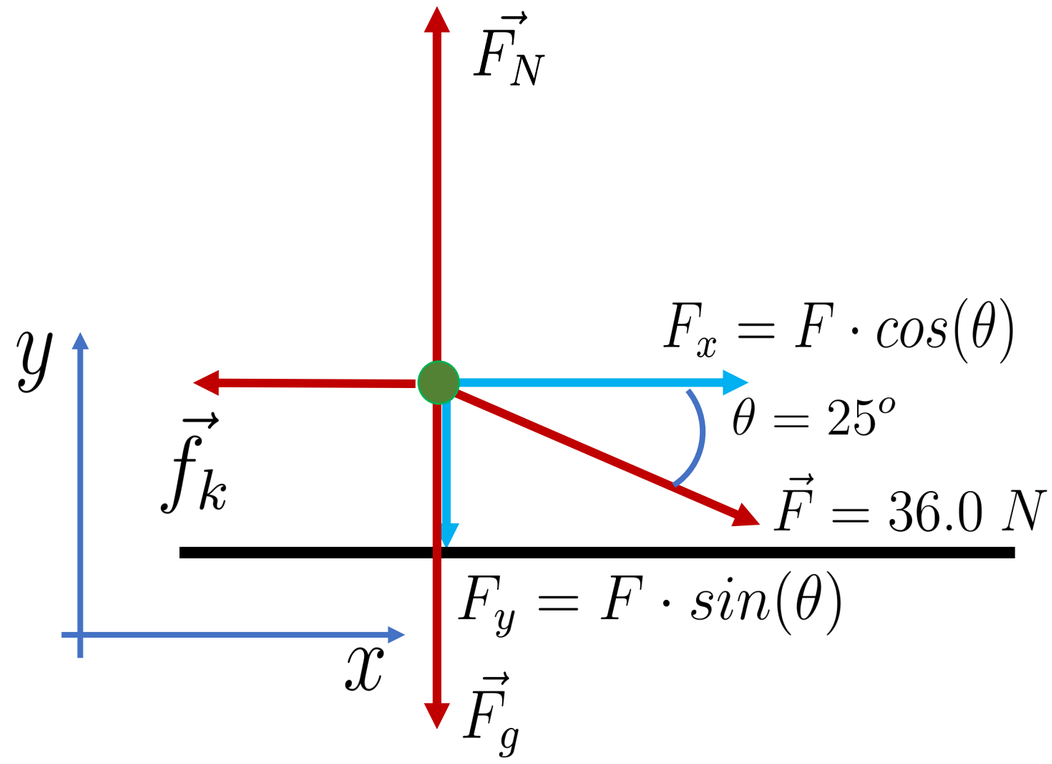
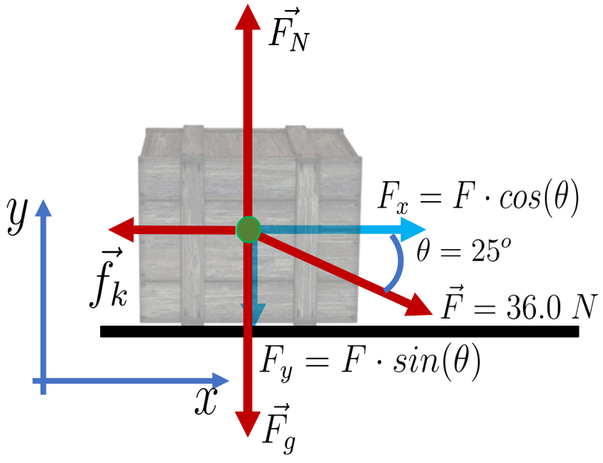
Newton's 2nd law

$$\sum \vec{F_{ext}} = m \cdot \vec{a}$$





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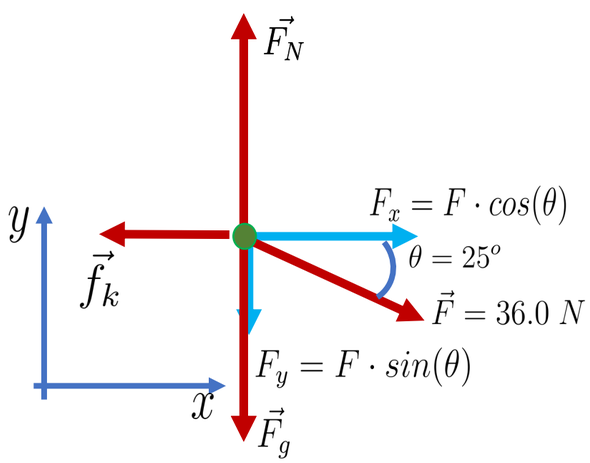
Newton's 2nd law

Y axis

$$\sum F_{ext,y} = m \cdot a_y$$



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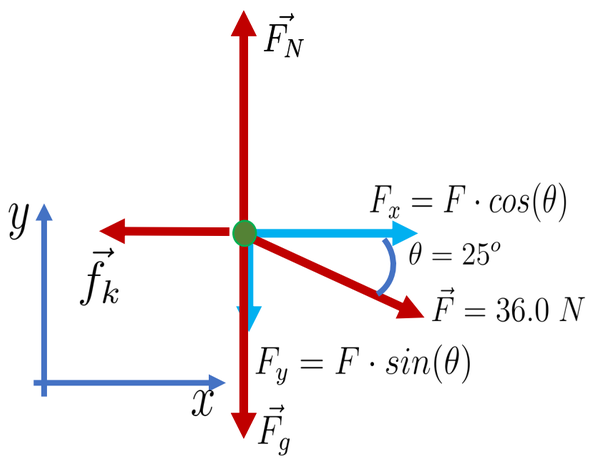
Newton's 2nd law

Y axis

$$\sum F_{ext,y} = m \cdot a_y$$

Solve for Normal Force



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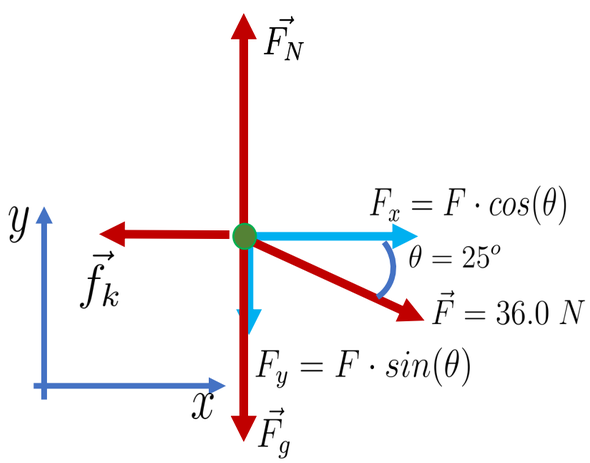
Newton's 2nd law

Y axis

$$\sum F_{ext,y} = m \cdot a_y$$

Solve for Normal Force

$$\sum F_{ext,y} = 0$$



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Newton's 2nd law

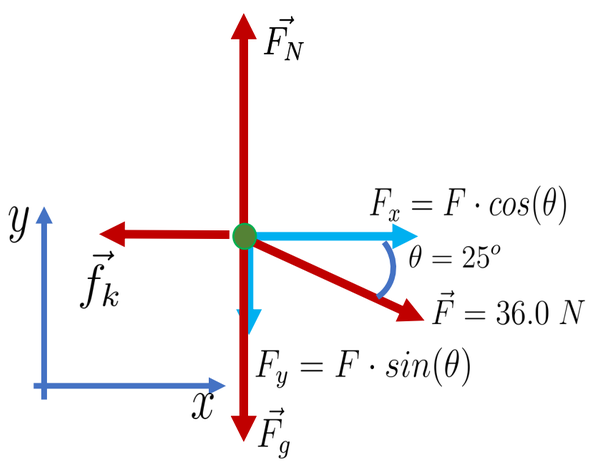
Y axis

$$\sum F_{ext,y} = m \cdot a_y$$

Solve for Normal Force

$$\sum F_{ext,y} = 0$$

$$F_N - F_g - F_y = 0$$



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Newton's 2nd law

Y axis

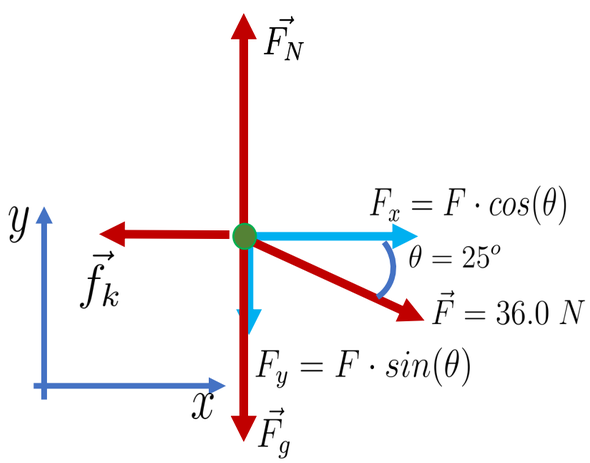
$$\sum F_{ext,y} = m \cdot a_y$$

Solve for Normal Force

$$\sum F_{ext,y} = 0$$

$$F_N - F_g - F_y = 0$$

$$F_N = F_g + F_y$$



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Newton's 2nd law

Y axis

$$\sum F_{ext,y} = m \cdot a_y$$

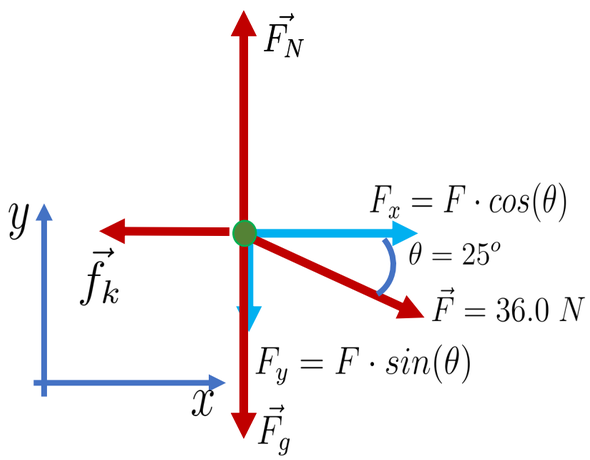
Solve for Normal Force

$$\sum F_{ext,y} = 0$$

$$F_N - F_g - F_y = 0$$

$$F_N = F_g + F_y$$

$$F_N = m \cdot g + F \cdot sin(\theta)$$



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Newton's 2nd law

Y axis

$$\sum F_{ext,y} = m \cdot a_y$$

Solve for Normal Force

$$\sum F_{ext,y} = 0$$

$$F_N - F_g - F_y = 0$$

$$F_N = F_g + F_y$$

$$F_N = m \cdot g + F \cdot sin(\theta)$$

$$F_N = 6.00\ kg \cdot 9.81\ \frac{m}{s^2} + 36.0\ N \cdot sin(25^0)$$

$$\boxed{F_N = 74.1\ N}$$

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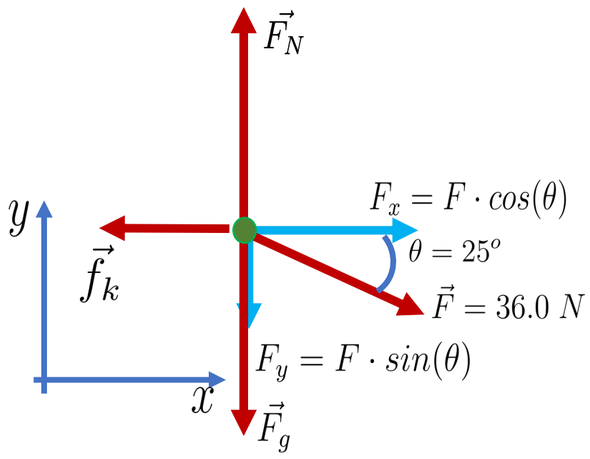
Using the normal force,
find the kinetic friction force

$$f_k = \mu_k \, F_N$$

$$f_k = 0.25 \cdot 74.1 \; N$$

$$\boxed{f_k = 18.5 \; N}$$



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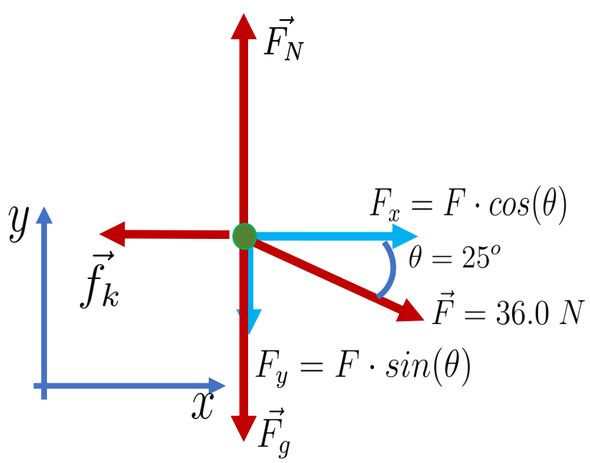
Newton's 2nd Law

X axis

$$\sum F_x = m\ a_x$$



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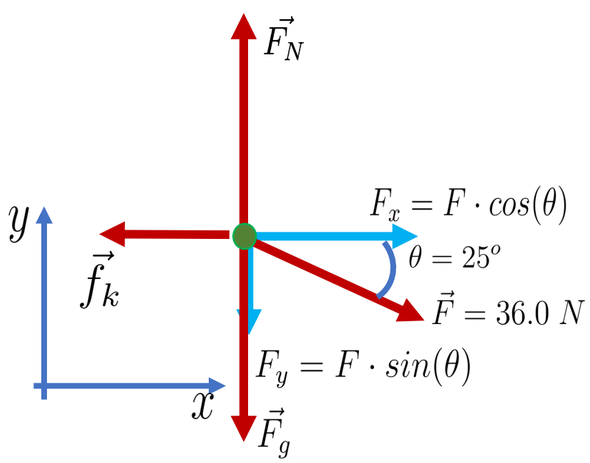
Newton's 2nd Law

X axis

$$\sum F_x = m\ a_x$$

Solve for acceleration



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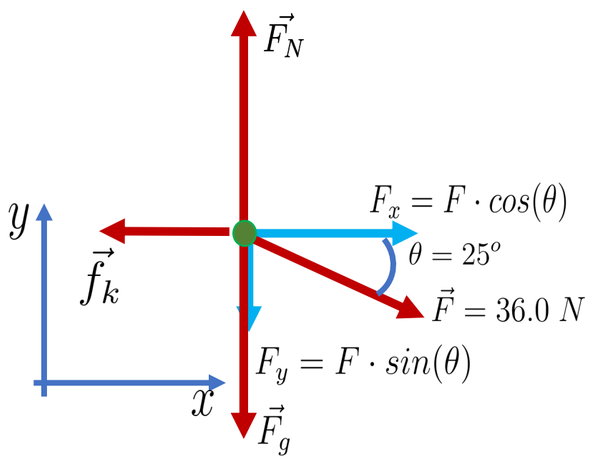
Newton's 2nd Law

X axis

$$\sum F_x = m\ a_x$$

Solve for acceleration

$$F_x\ -\ f_k\ =\ m\ \cdot\ a_x$$



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Newton's 2nd Law

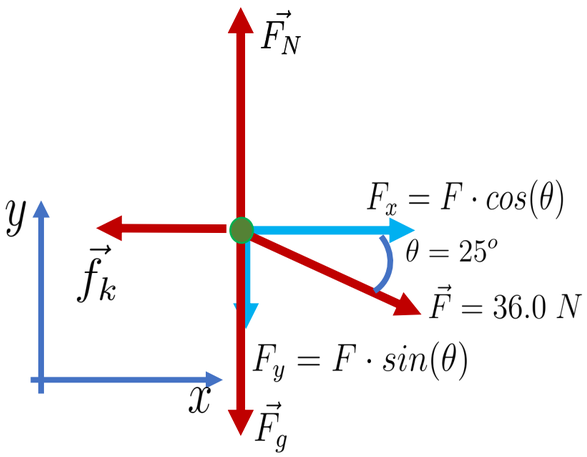
X axis

$$\sum F_x = m\ a_x$$

Solve for acceleration

$$F_x\ -\ f_k\ =\ m\ \cdot\ a_x$$

$$F \cdot cos(\theta)\ -\ f_k\ =\ m\ \cdot\ a_x$$



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Newton's 2nd Law

X axis

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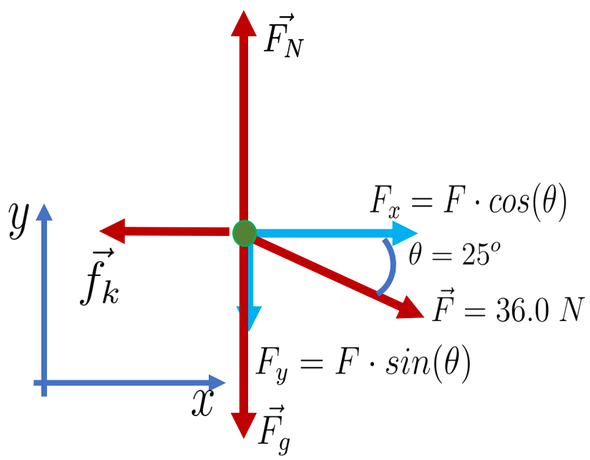
Solve for acceleration

$$F_x\ -\ f_k\ =\ m\ \cdot\ a_x$$

$$F \cdot cos(\theta)\ -\ f_k\ =\ m\ \cdot\ a_x$$

$$32.6\ N\ -\ 18.5\ N\ =\ 6.00\ kg\ \cdot\ a_x$$



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X axis

$$\sum F_x = m\ a_x$$

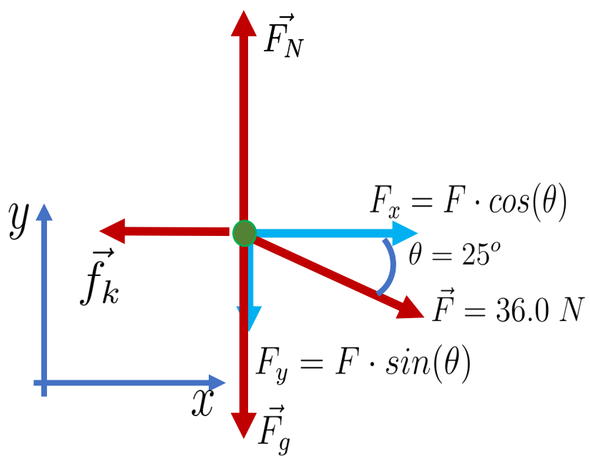
Solve for acceleration

$$F_x\ -\ f_k\ =\ m\ \cdot\ a_x$$

$$F\cdot cos(\theta)\ -\ f_k\ =\ m\ \cdot\ a_x$$

$$32.6\ N\ -\ 18.5\ N\ =\ 6.00\ kg\ \cdot\ a_x$$

$$\boxed{a_x\ =\ 2.35\ \frac{m}{s^2}}$$



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