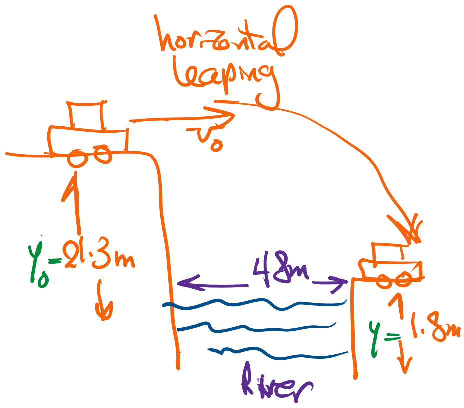
اثناء عاصفة

مرص

قفز

3.13 •• Leaping the River I. During a storm, a car traveling on a level horizontal road comes upon a bridge that has washed out. The driver must get to the other side, so he decides to try leaping the river with his car. The side of the road the car is on is 21.3 m above the river, while the opposite side is only 1.8 m above the river. The river itself is a raging torrent 48.0 m wide. (a) How fast should the car be traveling at the time it leaves the road in order just to clear the river and land safely on the opposite side? (b) What is the speed of the car just before it lands on the other side?



$$\boxed{\theta_0 = 0} \rightarrow v_0 = v_{0x}$$

$$v_{0y} = 0$$

$$\boxed{x - x_0 = 48\,m}$$ و

$$y - y_0 = 1.8 - 21.3 = -19.5\,m$$

(downward)

(a) $v_0 = ??$

(1) $$y - y_0 = \cancel{v_{0y} t}^{=0} + \frac{1}{2} g t^2$$

$$-19.5 = \frac{1}{2}(-9.8) t^2$$

$$t = \sqrt{\frac{19.5}{\frac{1}{2}(9.8)}} = 1.995\ sec$$

(2) $$x - x_0 = v_{0x} t$$

$$v_{0x} = v_0 = \frac{x - x_0}{t} = \frac{48}{1.995}$$

$$\boxed{v_0 = v_{0x} = 24.1 \ m/s}$$

OR

$$y = \cancel{x\tan\theta_0}^{=0} - \frac{g x^2}{2 v_0^2 (\cos\theta_0)^2}$$

$$\cancel{-}19.5 = \cancel{-} \frac{9.8(48)^2}{2 v_0^2 \cancel{(\cos 0)^2}^{=1}}$$

$$v_0 = \sqrt{\frac{9.8(48)^2}{2(19.5)(1)^2}} = \boxed{24.1} \ m/s$$

b) $v = ??$ $\longrightarrow$ (final $\overset{\text{magnitude}}{\text{velocity}}$) $\Rightarrow$ (speed)

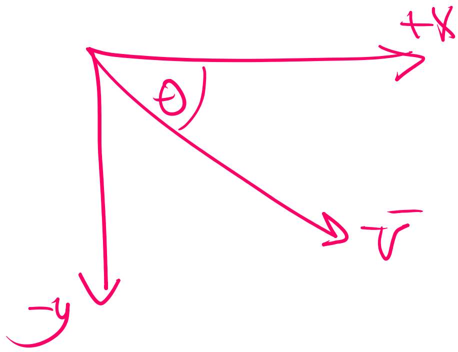
$* \ v_{0x} = v_x = +24.1 \ m/s$

$* \ v_y = \cancel{v_{0y}}^{=0} + gt$

$$v_y = -9.8(1.995) = -19.551 \ m/s$$

$$\bar{v} = \sqrt{v_x^2 + v_y^2} = \sqrt{(24.1)^2 + (-19.551)^2}$$

final velocity $\boxed{\bar{v} = 31 \ m/s}$



مصعد محمل   كابلات ضعيفة

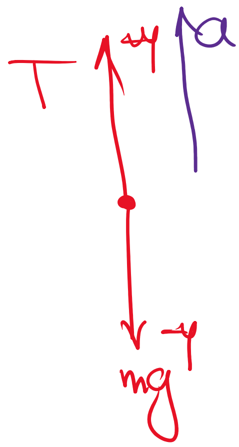
تتحمل

4.44 • A loaded elevator with very worn cables has a total mass of 2200 kg, and the cables can withstand a maximum tension of 28,000 N. (a) Draw the free-body force diagram for the elevator. In terms of the forces on your diagram, what is the net force on the elevator? Apply Newton's second law to the elevator and find the maximum upward acceleration for the elevator if the cables are not to break. (b) What would be the answer to part (a) if the elevator were on the moon, where $g = 1.62 \ m/s^2$?

for were on the moon, where $g = 1.62\ m/s^2$.

$$m_{total} = 2200\,kg \quad , \quad T_{max} = 28000\,N$$

(FBD for elevator)



(a) $a_y = ??$

$$\text{* net force} \quad \sum F j = ma j$$

$$* \ T j - mg j = ma j$$

$$* \ T - mg = ma$$

$$a_y = \frac{T - mg}{m} = \frac{(28000) - (2200 \times 9.8)}{2200}$$

$$a_y = 2.93\ m/s^2$$

(b) $a_y = ??$ $\left(g_{moon} = 1.62\ m/s^2\right)$

$$a_y = \frac{T - mg}{m} = \frac{28000 - (2200 * 1.62)}{(2200)}$$

$$\boxed{a_y = 11.1\ m/s^2}$$

دستقر ع   لوح ماكمد   سطح بلا احتكاك

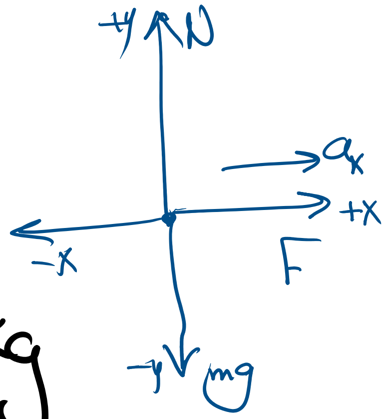
4.9 • A box rests on a frozen pond, which serves as a frictionless horizontal surface. If a fisherman applies a horizontal force with magnitude 48.0 N to the box and produces an acceleration of magnitude 2.20 m/s^2, what is the mass of the box?

صياد   يؤثر

$F = 48\,N$ و $a = 2.2\ m/s^2$

Using Newton's second law

FBD



$$\sum F_i = m a_i$$

$$F_i = m a_i$$

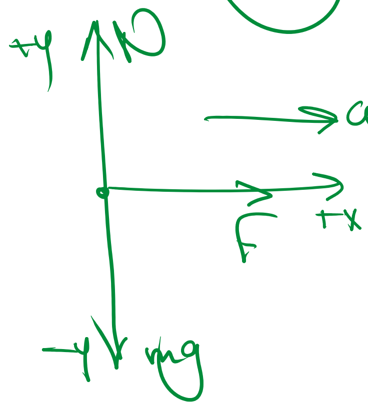
$$F = ma$$

$$m = \frac{F}{a} = \frac{48}{2.2} = 21.8\ Kg$$

4.12 • A crate with mass 32.5 kg initially at rest on a warehouse floor is acted on by a net horizontal force of 14.0 N. (a) What acceleration is produced? (b) How far does the crate travel in 10.0 s? (c) What is its speed at the end of 10.0 s?

$v_0 = 0$, $m = 32.5\ \text{Kg}$, $F = 14\ \text{N}$

FBD



(a) $a_x = ??$

$$\sum F_i = m a_i$$

$$F = ma$$

$$a_x = \frac{F}{m} = \frac{14}{32.5} = 0.431\ \text{m/s}^2$$

b) $X = ??$ $(t = 10\ \text{s})$

$$X = \cancel{v_0 t}^{=0} + \frac{1}{2} a t^2$$

$$X = \frac{1}{2} a t^2 = \frac{1}{2}(0.431)(10)^2 = 21.6\ \text{m}$$

(c) $v = ??$

$$v = \cancel{v_0}^{=0} + at$$

$$v = at = (0.431)(10) = 4.31\ \text{m/s}$$

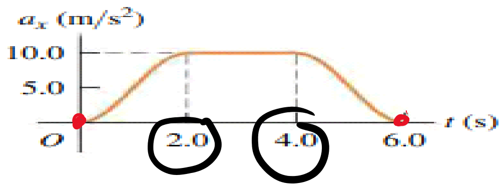
4.13 • A 4.50-kg experimental cart undergoes an acceleration in a straight line (the x-axis). The graph in **Fig. E4.13** shows this acceleration as a function of time. (a) Find the maximum net force on this cart. When does this maximum force occur? (b) During what times

تحدث

متى

is the net force on the cart a constant? (c) When is the net force equal to zero?

Figure E4.13



$$\boxed{m = 4.5\,\text{Kg}}$$

(a) $F_{max} = ??$

$$F_{max} = m a_{max} = (4.5)(10) = 45\,N$$

[This maximum force occurs between 2 sec and 4 sec]

(b) [The force is Constant between (2sec) and (4 sec)]

(c) Force is Zero at $t=0$, $t = 6$ sec

إناء

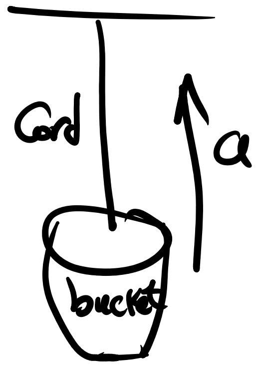
4.31 •• CP A 5.60-kg bucket of water is accelerated upward by a خيط cord of negligible mass whose breaking strength (Tension) is 75.0 N. If the bucket starts from rest, what is the minimum time required to raise the bucket a vertical distance (مسافة عمودية) of 12.0 m without breaking the cord?

$(m = 5.6\ kg)$

$T = 75\ N$

$v_0 = 0$

$y - y_0 = 12\ m$



$\sum F_y = ma_y$

$T - mg = ma$

$a = \frac{T - mg}{m}$

$a = \frac{75 - (5.6 * 9.8)}{(5.6)} = 3.59\ m/s^2$

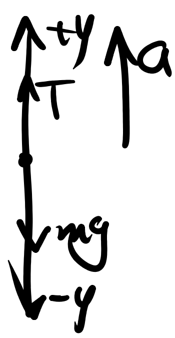
$y - y_0 = \cancel{v_0 t}^{=0} + \frac{1}{2}at^2$

$t = \sqrt{\frac{y - y_0}{\frac{1}{2}a}}$

$t = \sqrt{\frac{12}{(\frac{1}{2} * 3.59)}}$

$t = 2.59\ sec$

FBD



- **Applications – Newton's Second Law**

The system below includes 3 blocks of masses $m_1 = 1\ kg, m_2 = 2\ kg$ and $m_3 = 5\ kg$ linked by massless and frictionless strings and pulleys. We assume that m_1 is accelerating upward, m_2 from left to right and m_3 downward.

(a) Draw the FBD showing all the forces.

(b) Find the magnitude of the acceleration of the 3 blocks.

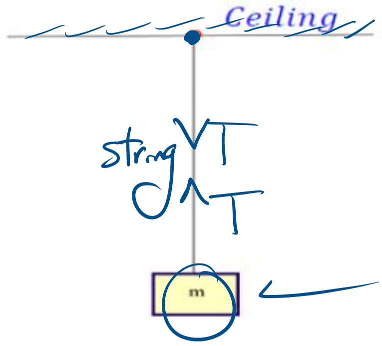
(c) Find the magnitude of the tension of the string between m_1 and m_2.

(d) Find the magnitude of the tension of the string between m_2 and m_3.

Application – Newtons 2nd and 3rd Law In Combination

معلق بـ وتر

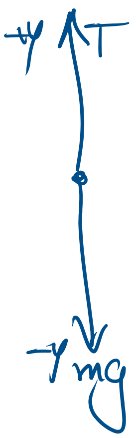
سقف A block of mass 5 Kg is suspended by a string to a ceiling and is at rest. Find the force F_c exerted by the ceiling on the string. Assume the mass of the string to be negligible.



$m = 5 Kg$

FBD for m and string

$\boxed{a=0}$



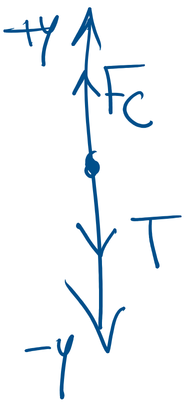
$$\sum F_j = 0$$

$$T - mg = 0$$

$$T = mg = 5 * 9.8 = 49 N$$

FBD (for string and ceiling)

$\boxed{a=0}$



$$\sum F_j = 0$$

$$F_C - T = 0$$

$$\boxed{F_C = T = 49N}$$

Application – Newtons 2nd and 3rd Law In Combination

دلامسون بعض

A 5.0-kg and a 10.0-kg box are touching each other. A 45.0-N horizontal force is applied to the 5.0-kg box in order to accelerate both boxes across the floor. Ignore friction forces and determine the acceleration of the boxes and the force acting between the boxes.

del

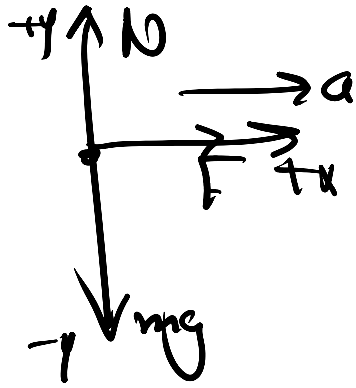
$m_1 = 5kg$

$m_2 = 10kg$

$F = 45N$

Take the two boxes as one box

$$m = m_1 + m_2 = 15kg$$



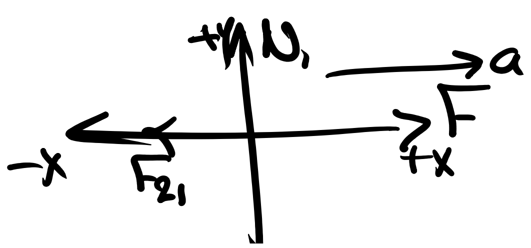
$$\sum F_i = m a_i$$

$$F = ma$$

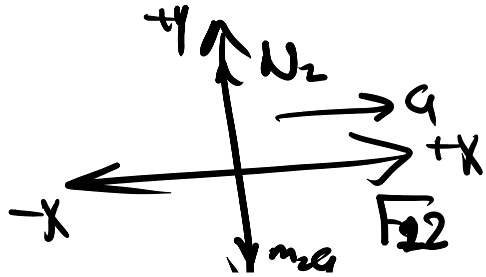
$$a = \frac{F}{m} = \frac{F}{m_1 + m_2}$$

$$a = \frac{45}{15} = 3\ m/s^2$$

FBD m_1



FBD m_2



Find contact force ($F_{Contact}$) $\boxed{F_{12} = -F_{21}}$

for m_2

$$\sum F_i = m_2 a_i$$

$$F_{12} = m_2 a$$

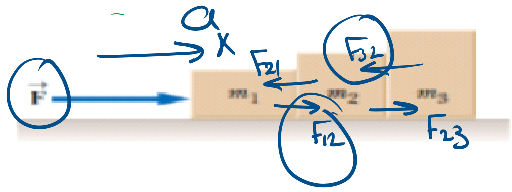
$$F_{12} = (10 \times 3) = 30\,N$$

$$\boxed{F_{Contact} = F_{12} = 30\,N}$$ +x direction

Application – Newtons 2nd and 3rd Law In Combination

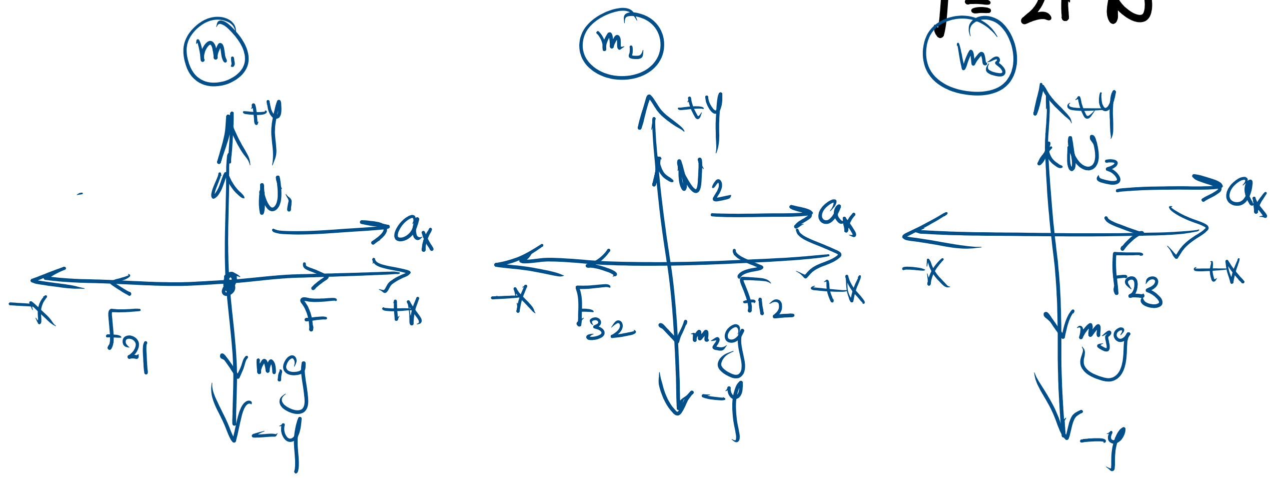
Three blocks are in contact with one another on a frictionless, horizontal surface as shown in the figure below. A horizontal force is applied to m_1. Take $m_1 = 2\ kg,\ m_2 = 3\ kg,\ m_3 = 4\ kg$, and $F = 27\ N$.

a) Draw a separate free-body diagram for each block.
b) Find the acceleration of the blocks
c) Find the resultant force on each block.
d) Find the magnitudes of the contact forces between the blocks



$m_1 = 2\,Kg$
$m_2 = 3\,Kg$
$m_3 = 4\,Kg$
$F = 27\,N$

ⓐ

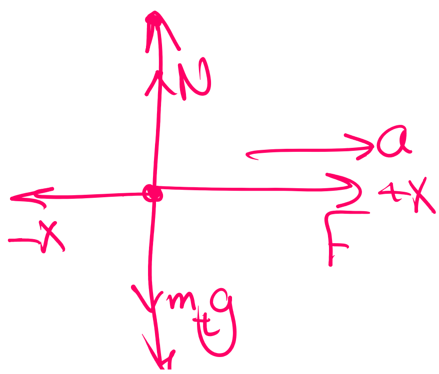


ⓑ $a = ??$ → [Taking the three blocks as one block $m = m_1 + m_2 + m_3 = 9\,Kg$]

$\sum F_i = m_t a_i$

$F = m_t a$

$\frac{F}{\ } = \frac{27}{\ }$



$$a = \frac{F}{m_t} = \frac{27}{9}$$

$m_t g$

$$\boxed{a = 3\ m/s^2}$$ for the three blocks

c, d

for m_1

$$\sum F_i = m_1 a_i$$

$$F - F_{21} = m_1 a$$

+ −

$$F_{21} = F - m_1 a = 27 - (2 * 3)$$

$$\boxed{F_{21} = 21\ N}$$ −x direction $\Longrightarrow (F_{21} = F_{12})$

for m_2

$$\sum F_i = m_2 a_i$$

$$F_{12} - F_{32} = m_2 a$$

+ −

$$F_{32} = F_{12} - m_2 a$$

$$F_{32} = (21) - (3*3)$$

$$\boxed{F_{32} = 12\,N \quad +x \text{ direction}} \Rightarrow (F_{32} = F_{23})$$

for m_3

$$\sum F_i = m_3 a_i$$

$$F_{23} = m_3 a = (4*3) = 12\,N$$

(+x direction)

Application – Newtons 2nd and 3rd Law In Combination

$m = 5\ Kg$

$F_a = 30\ N$

A particle of mass 5 Kg rests on a 30° inclined plane with the horizontal. A force F_a of magnitude 30 N acts on the particle in the direction parallel and up the inclined plane.

a) Draw a FBD including the particle, the inclined plane and all forces acting on the particle with their inclined plane.

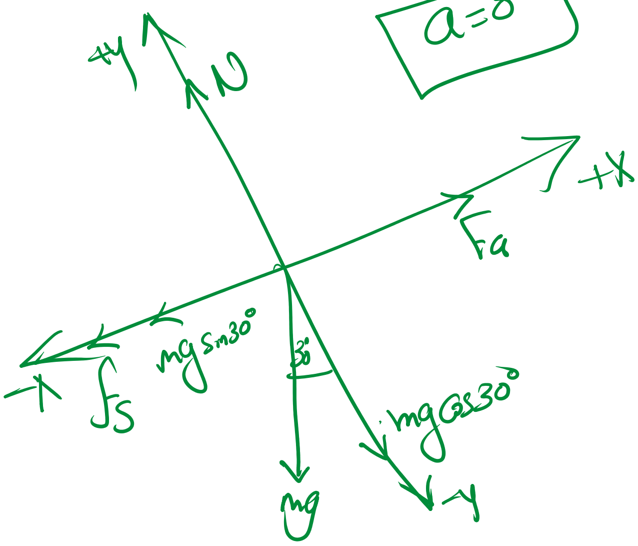
a) Draw a FBD including the particle, the inclined plane and all forces acting on the particle with their labels.

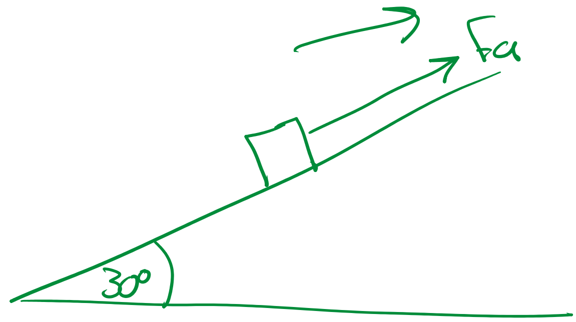
b) Find the force of friction acting on the particle.

c) Find the normal force exerted by the inclined on the particle.

(a=0)

a





b

$$\sum F_i = 0$$

$$F_a - mg\sin 30^\circ - f_s = 0$$

+

$$f_s = F_a - mg\sin 30^\circ$$

$$f_s = (30) - (5 * 9.8 \sin 30^\circ)$$

$$\boxed{f_s = 5.5\ N}$$

c

$$N = ??$$

N = :

$$\sum F_j = 0$$

$$N - mg\cos 30^\circ = 0$$

$$N = mg\cos 30^\circ$$

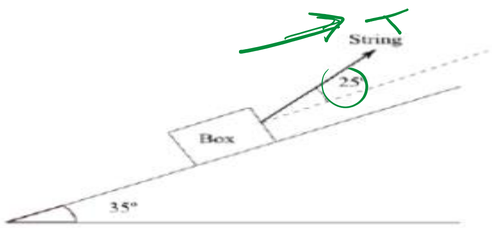
$$N = (5 * 9.8 \cos 30^\circ)$$

$$\boxed{N = 42.4\ N}$$

Your Turn – Newtons 2nd and 3rd Law In Combination

- *A box of mass M = 10 Kg rests on a 35° inclined plane with the horizontal. A string is used to keep the box in equilibrium. The string makes an angle of 25 ° with the inclined plane. The coefficient of friction between the box and the inclined plane is 0.3.*

(a) Draw a Free Body Diagram including all forces acting on the particle with their labels.
(b) Find the magnitude of the tension T in the string.
(c) Find the magnitude of the force of friction acting on the particle.

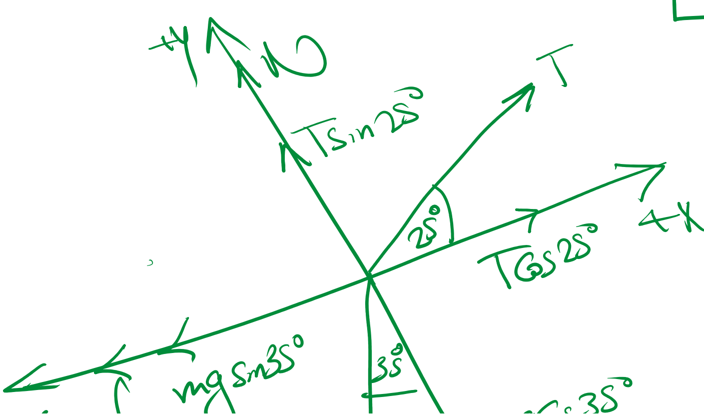


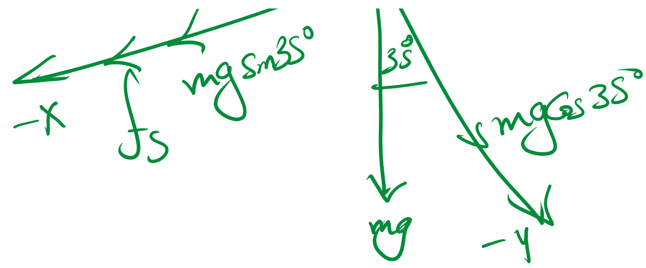
$m = 10\,Kg$

$a = 0$

$\mu_s = 0.3$

$\boxed{a = 0}$





$$* \quad \sum F_j = 0$$

$$N + T\sin 25^\circ - mg\cos 35^\circ = 0$$

$$\boxed{N = mg\cos 35^\circ - T\sin 25^\circ} \rightarrow \#$$

$$* \quad \sum F_i = 0$$

$$T\cos 25^\circ - mg\sin 35^\circ - f_s = 0$$

$$T\cos 25^\circ - mg\sin 35^\circ - \mu_s N = 0 \quad \#$$

$$T\cos 25^\circ - mg\sin 35^\circ - \mu_s(mg\cos 35^\circ - T\sin 25^\circ) = 0$$

$$T\cos 25^\circ - mg\sin 35^\circ - \mu_s mg\cos 35^\circ + \mu_s T\sin 25^\circ = 0$$

$$T\cos 25^\circ + \mu_s T\sin 25^\circ = mg\sin 35^\circ + \mu_s mg\cos 35^\circ$$

$$T(\cos 25^\circ + \mu_s \sin 25^\circ) = mg(\sin 35^\circ + \mu_s\cos 35^\circ)$$

$$T = \frac{mg\left(\sin 35^\circ + \mu_s \cos 35^\circ\right)}{\cos 25^\circ + \mu_s \sin 25^\circ}$$

$$T = \frac{(10 * 9.8)\left(\sin 35^\circ + 0.3 \cos 35^\circ\right)}{\left(\cos 25^\circ + 0.3 \sin 25^\circ\right)}$$

(Tension) $T = 77.7\ N$

(c)

$$f_s = \mu_s N$$

$$f_s = \mu_s \left(mg \cos 35^\circ - T \sin 28^\circ\right)$$

$$= 0.3\left[\left(10 * 9.8 \cos 35^\circ\right) - \left(77.7 * \sin 25^\circ\right)\right]$$

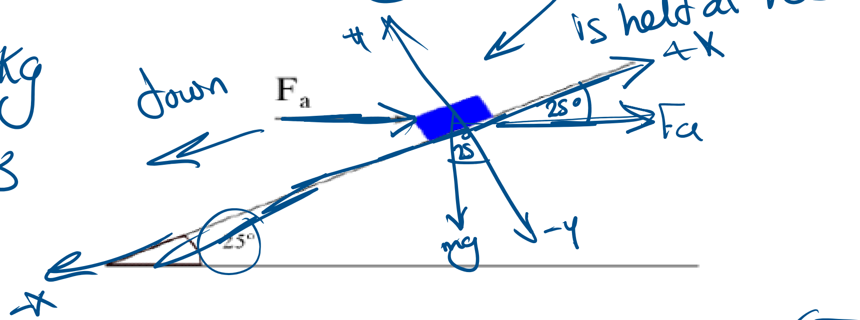
$$= 14.33 \qquad N$$

Your Turn – Newtons 2nd and 3rd Law In Combination

مثبت

A box of mass M = 7 Kg is held at rest on a 25° inclined plane by force F_a acting horizontally as shown in the figure below. The box is on the point of sliding down the inclined plane. The static coefficient of friction between the box and the inclined plane is $\mu_s = 0.3$.

Find the magnitude of force F_a.



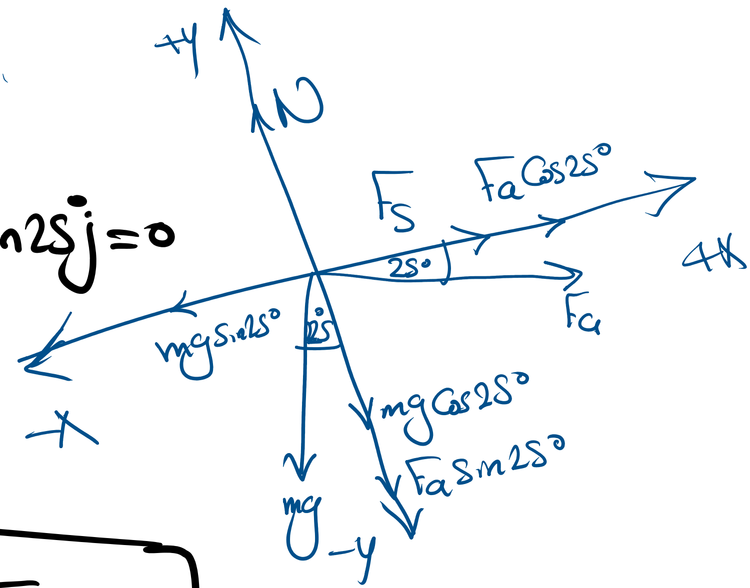
$m = 7\,Kg$

$\mu_s = 0.3$

$F_a = ??$

(FBD)

$\boxed{a = 0}$



$* \quad \sum F_j = 0$

$N\hat{j} - mg\cos 25°\hat{j} - F_a \sin 25°\hat{j} = 0$

$N - mg\cos 25° - F_a \sin 25° = 0$

$$\boxed{N = mg\cos 25° + F_a \sin 25°} \quad \#$$

$* \quad \sum F_i =$

$$F_a \cos 25^\circ + f_s - mg \sin 25^\circ = 0$$

$$F_a \cos 25^\circ + \mu_s N - mg \sin 25^\circ = 0 \quad \#$$

$$F_a \cos 25^\circ + \mu_s (mg \cos 25^\circ + F_a \sin 25^\circ) - mg \sin 25^\circ = 0$$

$$F_a \cos 25^\circ + \mu_s mg \cos 25^\circ + \mu_s F_a \sin 25^\circ - mg \sin 25^\circ = 0$$

$$F_a \cos 25^\circ + \mu_s F_a \sin 25^\circ = mg \sin 25^\circ - \mu_s mg \cos 25^\circ$$

$$F_a (\cos 25^\circ + \mu_s \sin 25^\circ) = mg \sin 25^\circ - \mu_s mg \cos 25^\circ$$

$$F_a = \frac{mg \sin 25^\circ - \mu_s mg \cos 25^\circ}{\cos 25^\circ + \mu_s \sin 25^\circ}$$

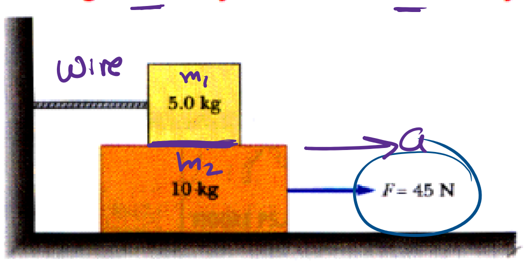
$$F_a = \frac{(7 * 9.8 \sin 25^\circ) - (0.3 * 7 * 9.8 \cos 25^\circ)}{(\cos 25^\circ \ldots)}$$

$$F_a = \frac{(7 \times 9.8 \sin 25) - (0.3 \times 7 \times 9.8 \cos 25)}{(\cos 25^\circ + 0.3 \sin 25^\circ)}$$

$$\boxed{F_a = 10.01 \text{ N}}$$

Your Turn – Newtons 2nd and 3rd Law In Combination

A 5.0-kg block is placed on top of a 10-kg block. A horizontal force of 45 N is applied to the 10-kg block, and the 5.0 kg block is tied مربوط to the wall. All the surfaces are frictionless. بلا احتكاك
(a) Draw a free-body diagram for each block and identify the action-reaction forces between the blocks.
(b) Determine the normal force acting on the block of mass 10 kg and the magnitude of the acceleration of the 10-kg block.



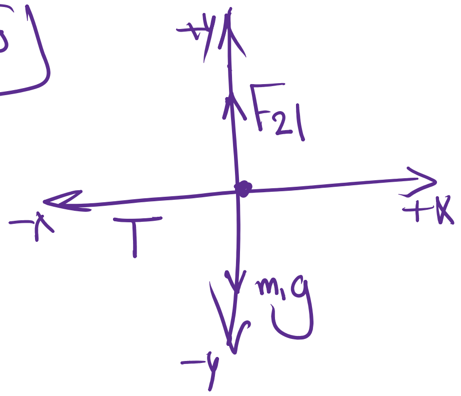
$F = 45N$

$m_1 = 5kg$

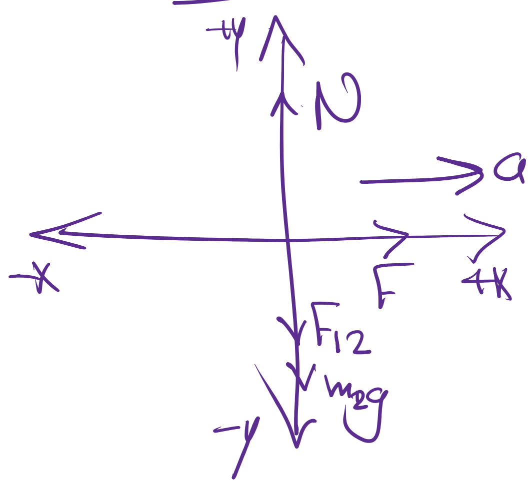
$m_2 = 10\ kg$

(a) FBD (m_1)

$\boxed{a=0}$



(a) FBD (m_2)



(b)

for (m_1)

$$\sum F_j = 0$$

$$F_{21} - m_1 g = 0$$

$$F_{21} = m_1 g = 5 * 9.8 = 49N$$

$$\boxed{F_{21} = 49\,N}$$

for (m_2)

$$\sum F_j = 0$$

$$N - F_{12} - m_2 g = 0$$

$$N = F_{12} + m_2 g$$

$$N = 49 + (10 * 9.8)$$

$$\boxed{F_{21} = 49\,N}$$

$$\left(F_{21} = F_{12} = 49\,N\right)$$

in opposite direction

$$N = 49 + (10 \times 9.8)$$

$$\boxed{N = 147\,N}$$

$$* \quad \sum F_i = m_2 a_i$$

$$F = m_2 a$$

$$a = \frac{F}{m_2} = \frac{45}{5} = 9\,\frac{m}{s^2}$$