Good morning!

Today is "Monday" => Lab4!

IF the lecture ends early, the rest of the time = Q&A

Please, sign in, login into webassing, locate LectureMCQ_L8 (PY105) and answer question 1 (but ONLY Q1 !)

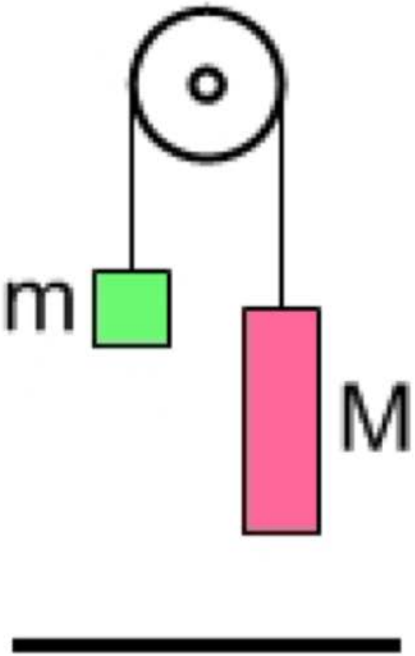
NOTE: Exam 1 is on Monday, June 4, 8:30 – 10:30 am, in LSE B01

Hint: arrive ~ 8-15

Lab4 is in SCI 134

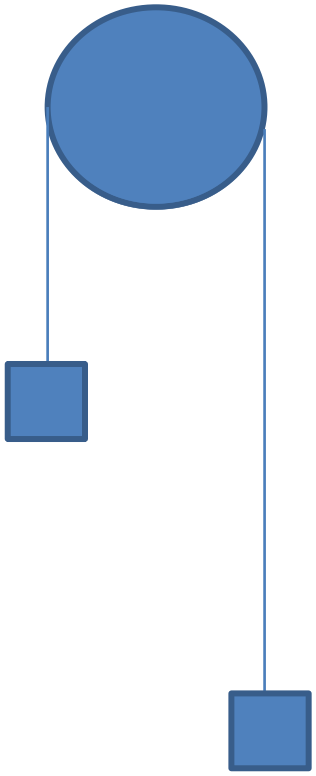
Atwood's machine

Atwood's machine involves one pulley, and two objects connected by a string that passes over the pulley. In general, the two objects have different masses.

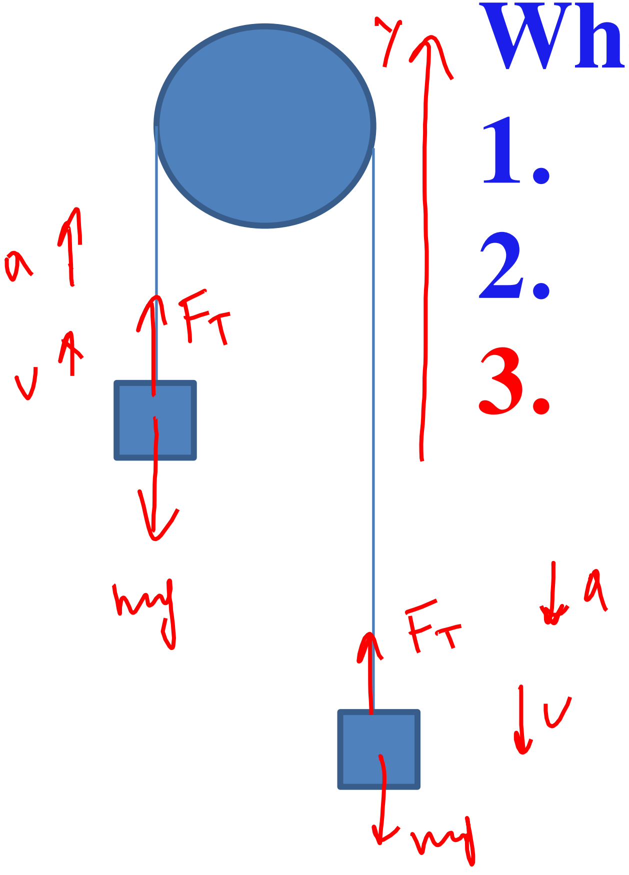


Two identical weights are attached to the string as shown. When we release the weights from rest:

1. The left one begins moving up (the right moves down).
2. The right one begins moving up (the left moves down).
3. Both weights begin moving up.
4. They will not move.
5. The string breaks.



LectureMCQL8_Q2



When acceleration is zero, velocity is…

1. Also zero
2. Negative
3. Constant
4. Hidden
5. Increasing
6. Red

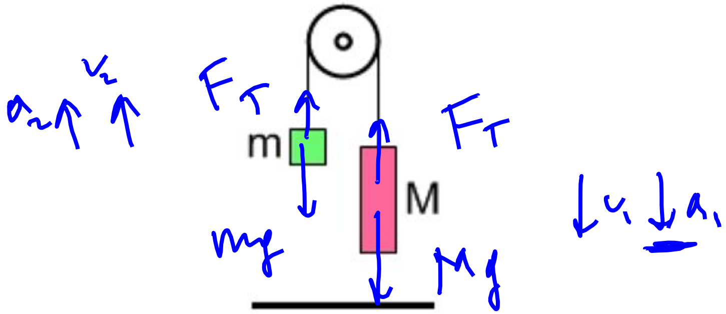
$$F_T - mg = ma$$
$$F_T - mg = m(-a)$$
$$\Downarrow$$
$$ma = m(-a)$$
$$a = -a \qquad 2a = 0 \qquad a = 0 \Rightarrow V = \text{const}$$

$$V = V_0 + at$$

LectureMCQL8_Q3

Atwood's machine

Atwood's machine involves one pulley, and two objects connected by a string that passes over the pulley. In general, the two objects have different masses.



$|a_1| = |a_2| = a \qquad |v_1| = |v_2| = v$

N2L: $\sum \vec{F} = m\vec{a}$

$F_T - mg = m \cdot a$

$F_T - Mg = M \cdot a(-) \qquad \times(-1)$

$-F_T + Mg = Ma$

$+$

$-F_T + Mg = Ma$

$F_T - F_T - mg + Mg = m \cdot a + M \cdot a$

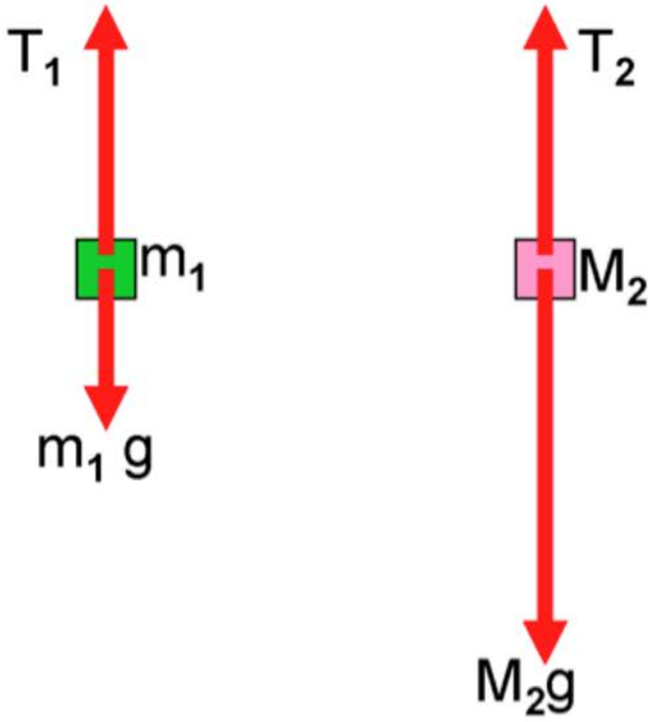
$(M - m) \cdot g = (m + M) \cdot a$

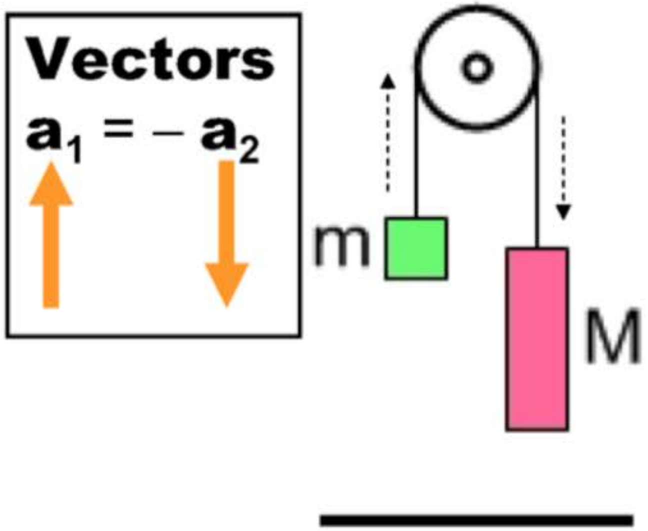
$a = \frac{M-m}{M+m} \cdot g$

$g = \frac{m+M}{M-m} \cdot a$

$m, g, M \rightarrow F_T, a$

Dealing with pulleys





String **<u>force</u>:**

Magnitudes $T_1 = T_2 = T$ (an ideal case)

Both are **up**, because strings <u>pull</u>.

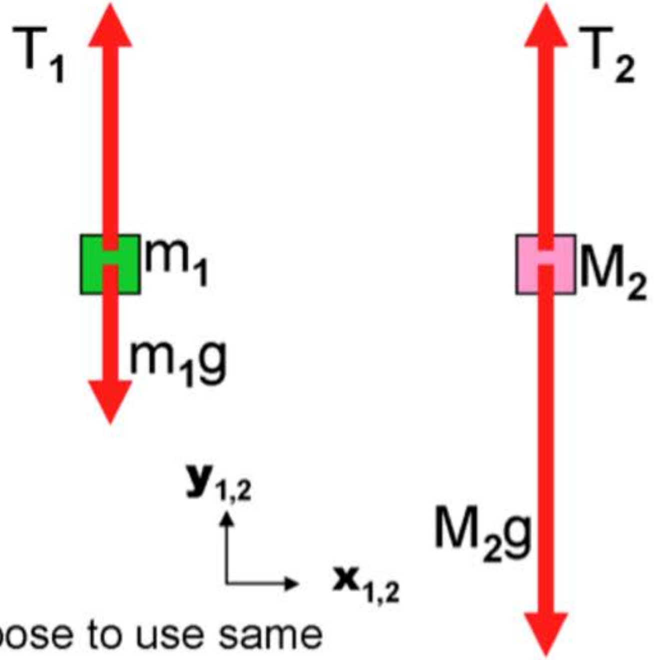
String **<u>constraint</u>:** If 1 goes **up**, 2 goes **down** by the <u>same amount</u>.

This holds for changes too, so it holds for their **velocities**, $\mathbf{v}_1 = -\mathbf{v}_2$

and then for their **accelerations,**

$$\mathbf{a}_1 = -\mathbf{a}_2$$

Dealing with pulleys

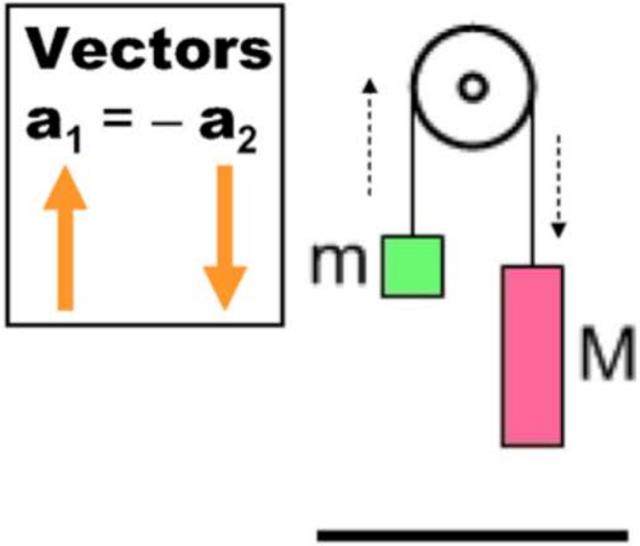


I choose to use same coordinate system for both

$$T - m_1 g = m_1 a$$

$$T - M_2 g = M_2(-a)$$

$$(M_2 - m_1)g = (M_2 + m_1)a$$



Everything in the x direction is zero. Just do equations for y.

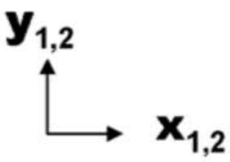
String: $T_{1y} = T \qquad a_{1y} = +a$

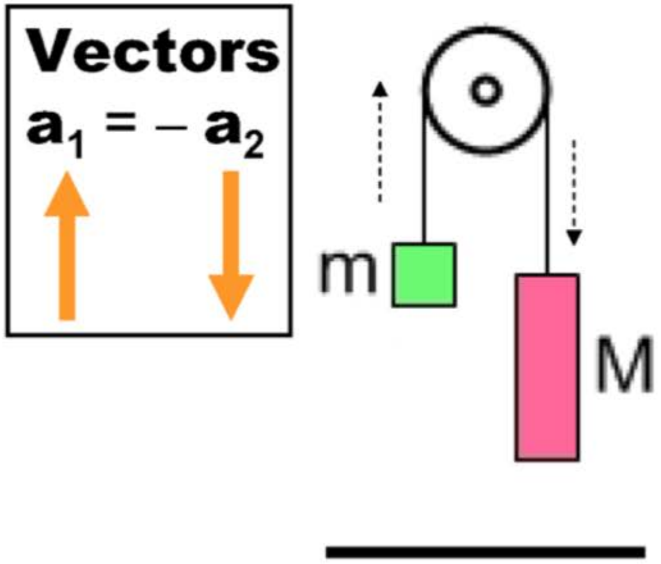
$T_{2y} = T \qquad a_{2y} = -a$

Gravity: $W_{1y} = -m_1 g$

$W_{2y} = -M_2 g$

Dealing with pulleys





$(M_2 - m_1)g = (M_2 + m_1)a$,
so that

$$\frac{(M_2 - m_1)}{(M_2 + m_1)} g = a$$

M = 210 g and m = 200 g.

$$a = \frac{10}{410} * g = 0.24 \text{ m/s}^2$$

For M > m, a > 0, and m accelerates **up**.

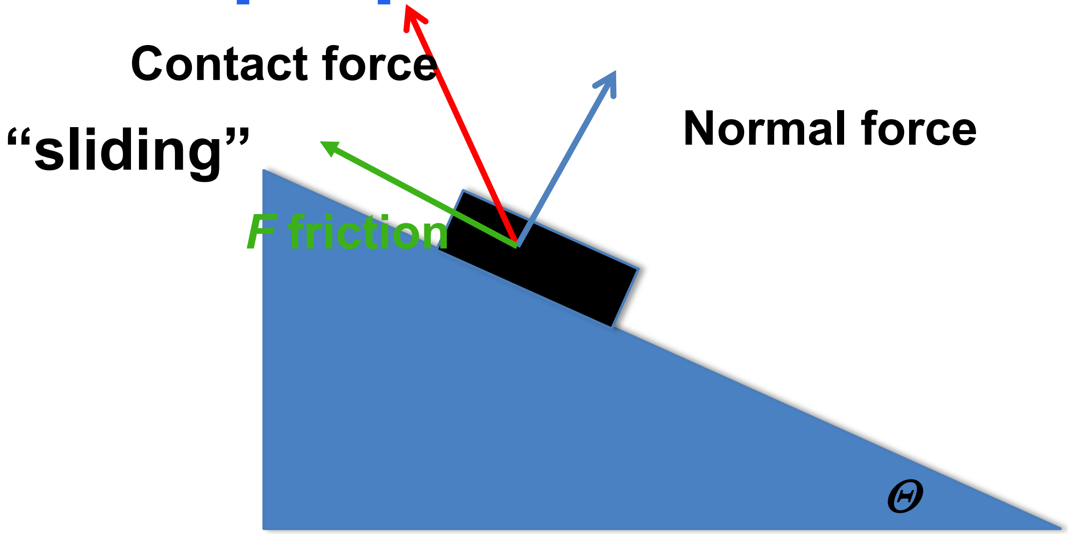
For M = m, a = 0, and m moves with constant velocity up or down, including remaining at rest.

For M < m, a < 0, and m accelerates **down**.

If m = 0, $a_{2y} = -g$, and M falls freely.

An official definition of a **normal force:**

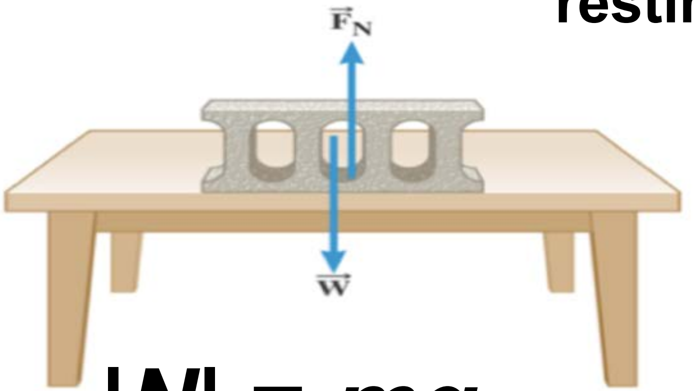
It is a <u>component</u> of a contact force which is perpendicular to a surface.



$|N| \neq mg$

Normal force is equal to whatever N2L makes it to be equal to.

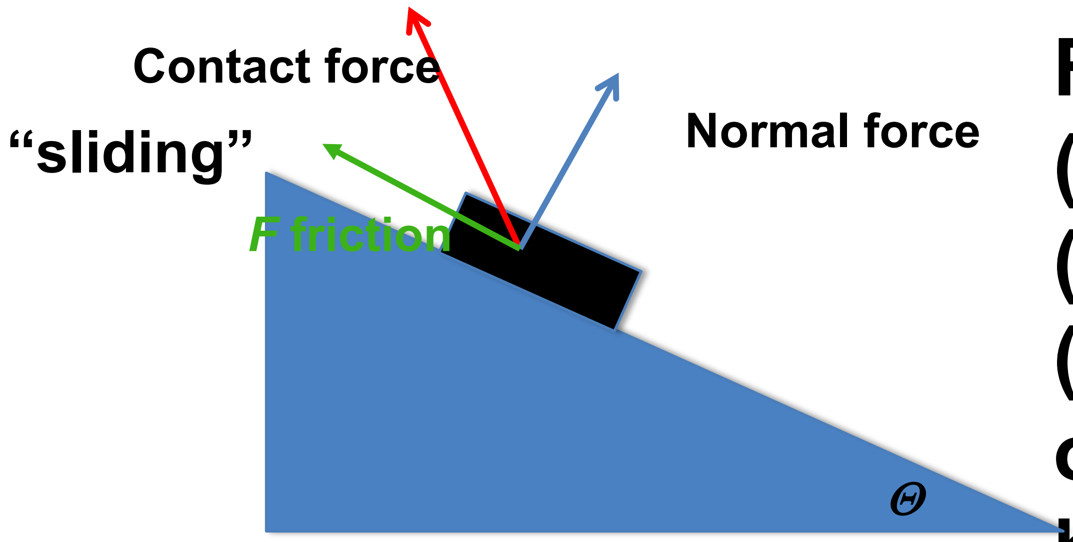
"resting"



$|N| = mg$

An official definition of a **frictional force:**

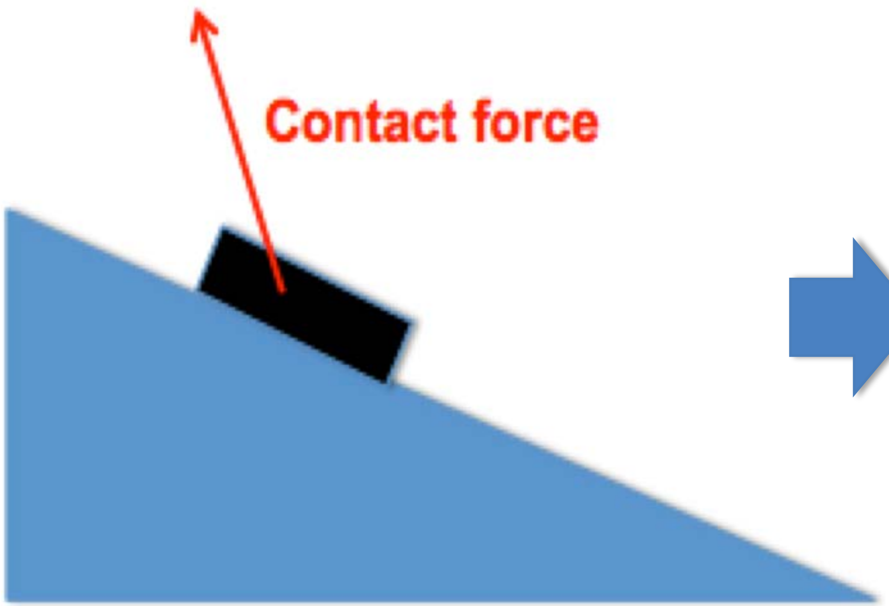
It is a component of a contact force which is parallel to a surface.

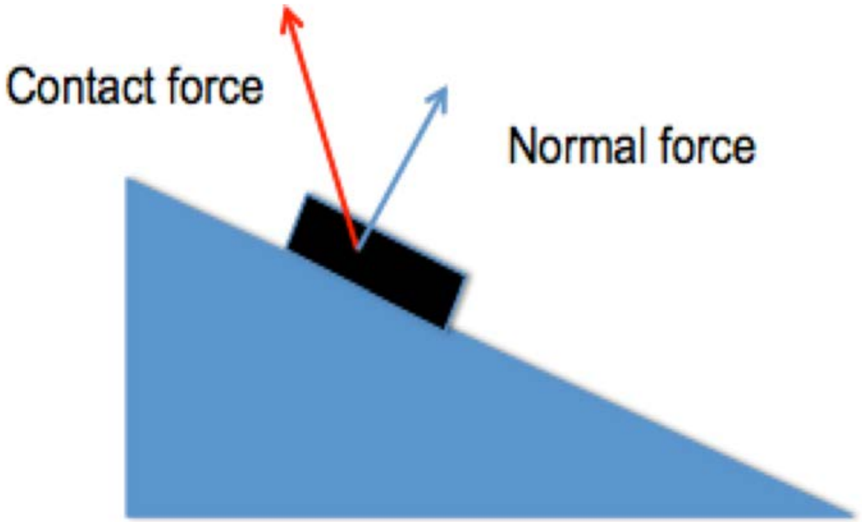


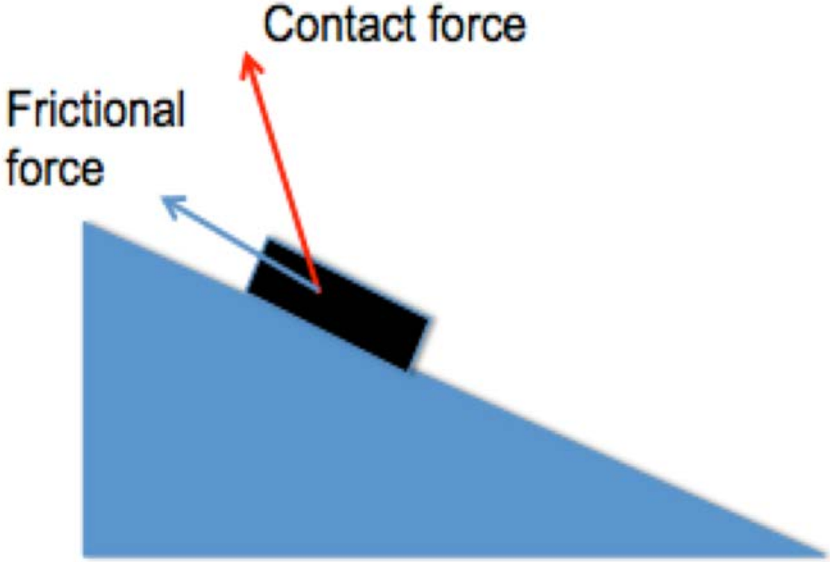
$|N| \neq mg$

Force of friction points:
(a) Opposite to velocity (for a moving object);
(b) Opposite to velocity of an object if would have had if friction would not prevent it from moving.

A contact force

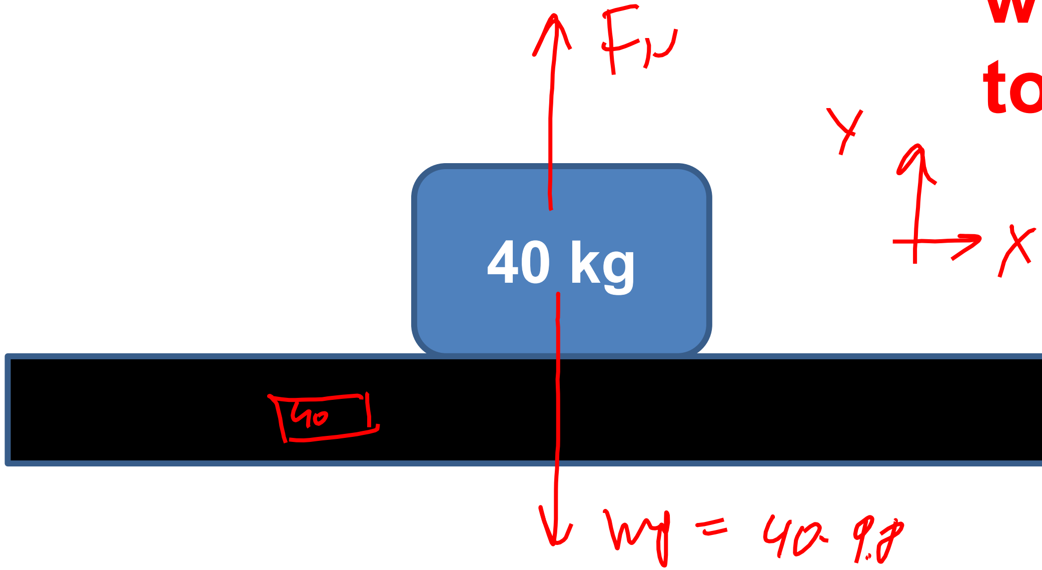






$$|CF| = \sqrt{(NF)^2 + (F_rF)^2}$$

Calculate the normal force for a resting box (use g = 10 m/s^2).



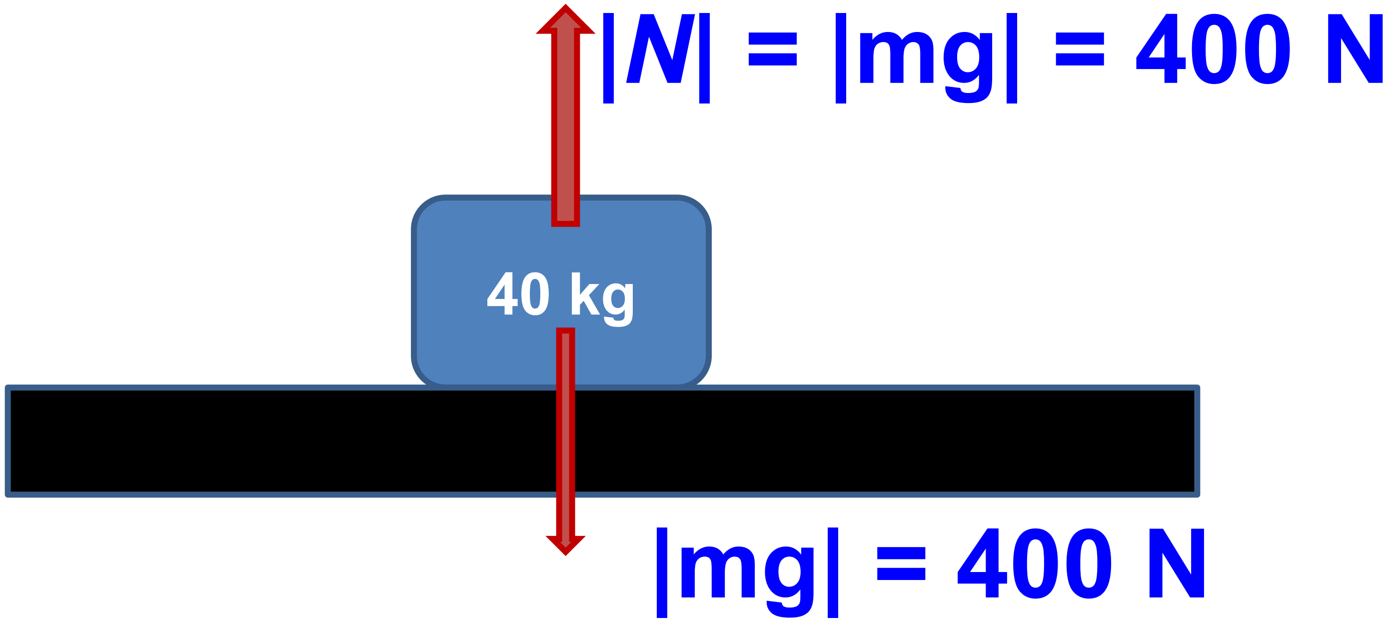
Normal force is equal to whatever N2L makes it to be equal to.

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

$$y: \quad F_N - mg = m \cdot 0$$

$$F_N = m \cdot g =$$

Calculate the normal force for a resting box (use g = 10 m/s²).

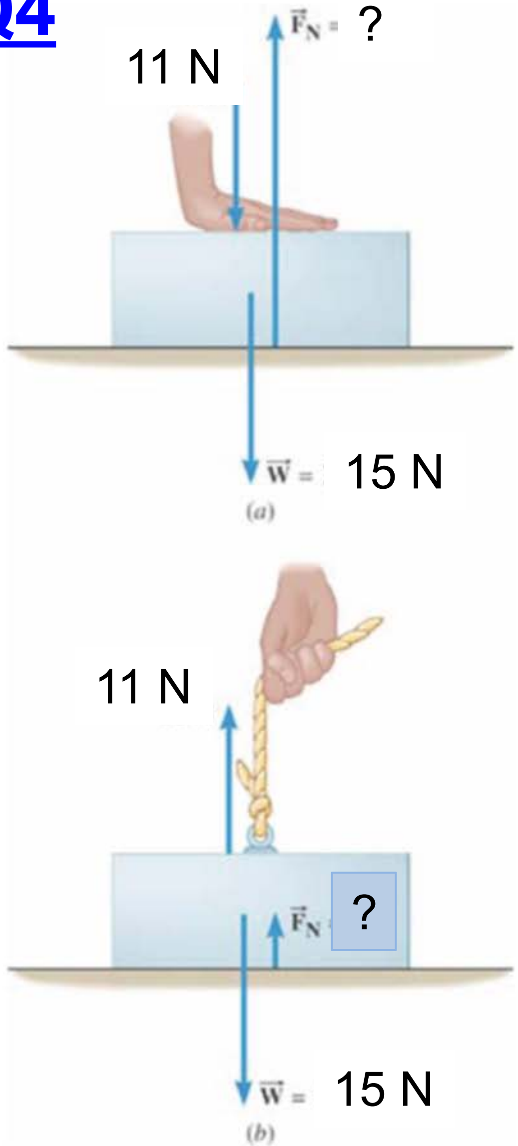


LectureMCQ L8 Q4

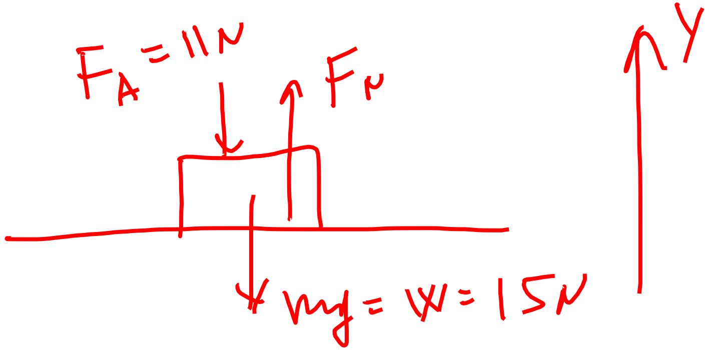
Normal forces in the pictures on the right are…

1. 11 N and 15 N
2. 11 N and 26 N
3. 4 N and 11 N
4. 11 N and 26 N
5. None of the above
6. None of the below
7. None

W = mg

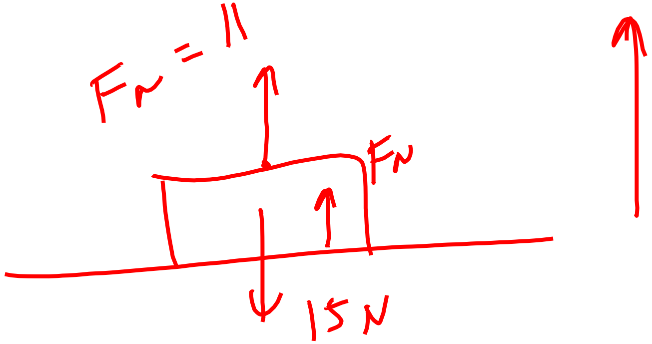


Calculate the normal force for a resting box



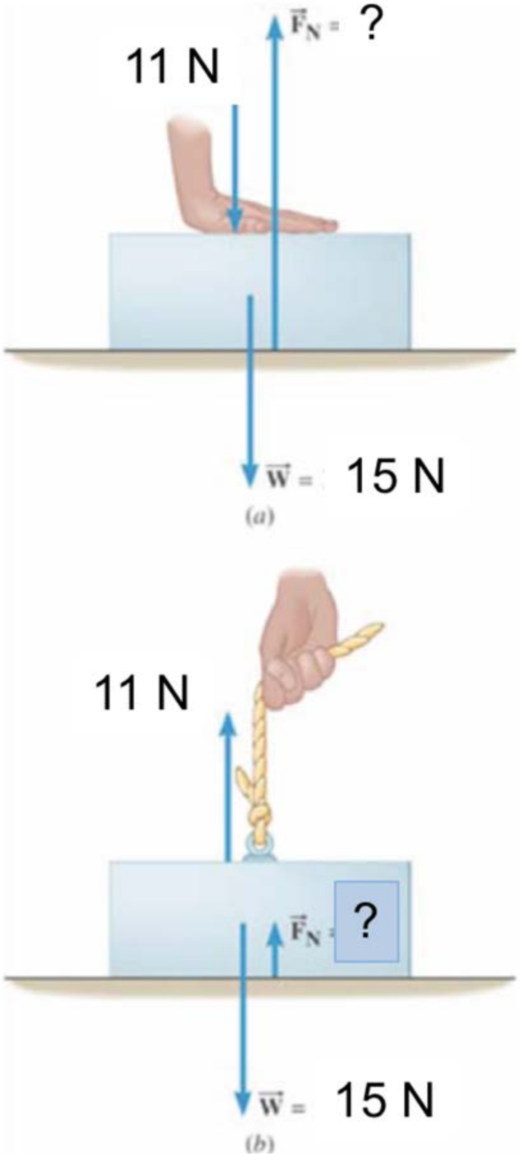
$$F_N - 11 - 15 = m \cdot 0$$

$$F_N = 26N$$



$$F_N + 11 - 15 = m \cdot 0$$

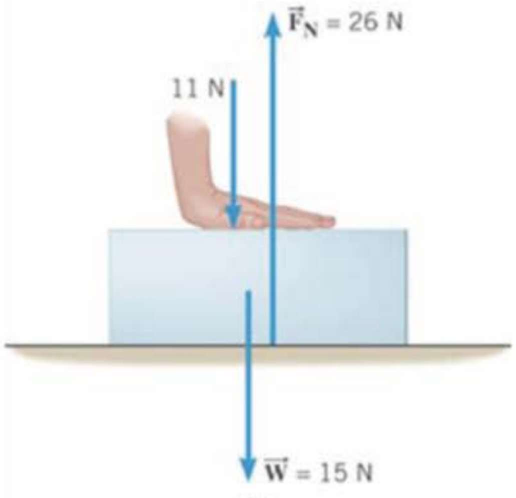
$$F_N = 15 - 11 = 4N$$



The Normal Force

$$F_N - 11\,\mathrm{N} - 15\,\mathrm{N} = 0$$

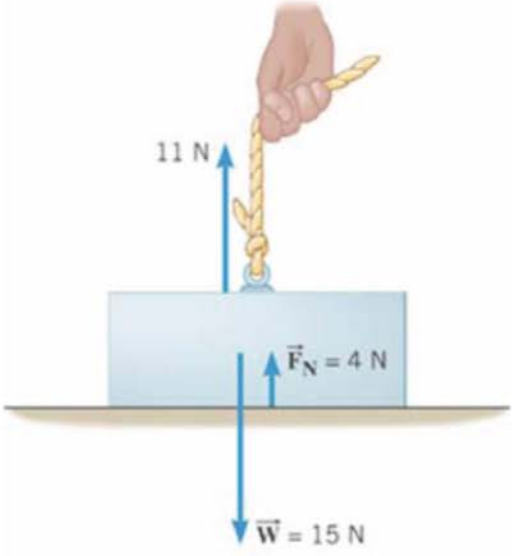
$$F_N = 26\,\mathrm{N}$$



(a)

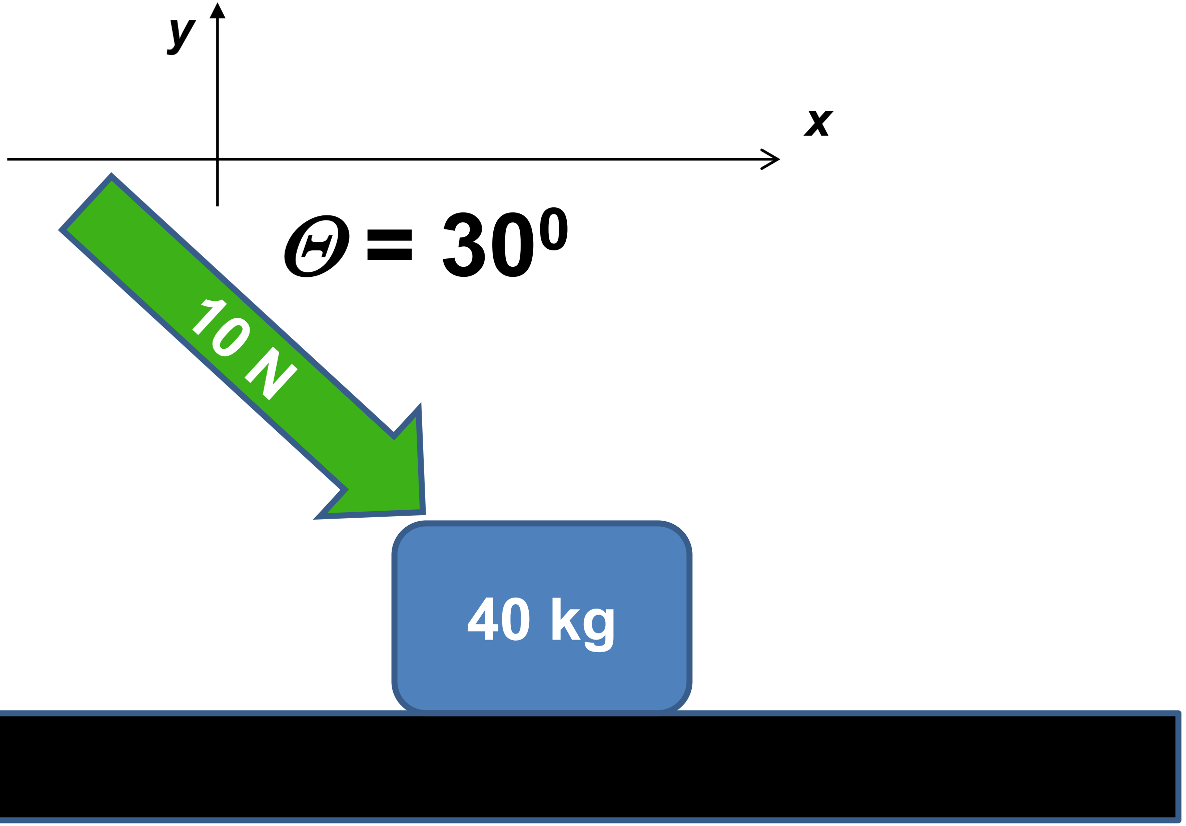
$$F_N + 11\,\mathrm{N} - 15\,\mathrm{N} = 0$$

$$F_N = 4\,\mathrm{N}$$



(b)

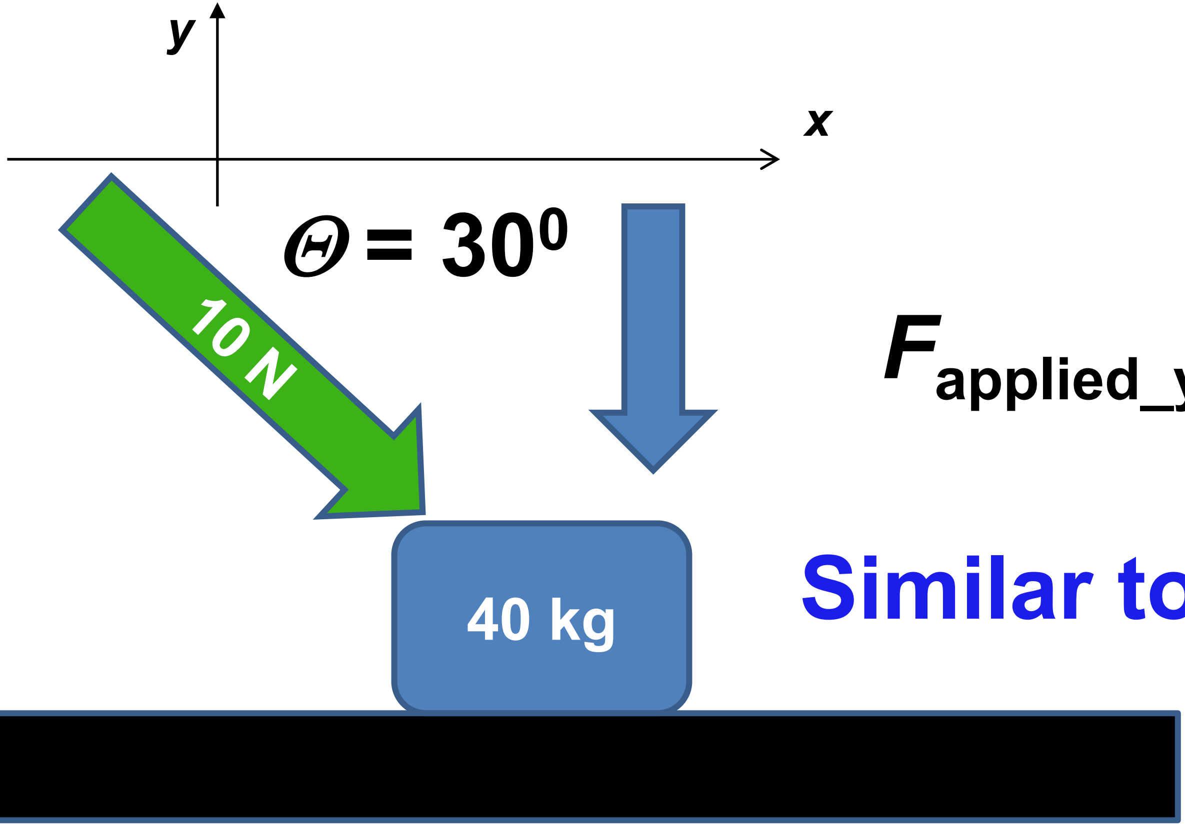
Calculate the normal force when an additional force is acting on the box at 30^0 to the horizontal direction (use $g = 10\ m/s^2$).



Webassign: L8 Q5

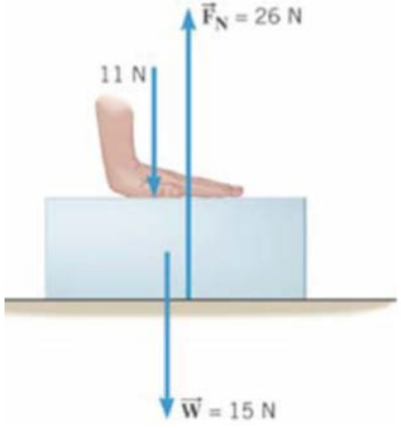
1. $|N| = 400$ N
2. $|N| > 400$ N
3. $|N| < 400$ N

Calculate the normal force when an additional force is acting on the box at 30^0 to the horizontal direction (use $g = 10\ m/s^2$).



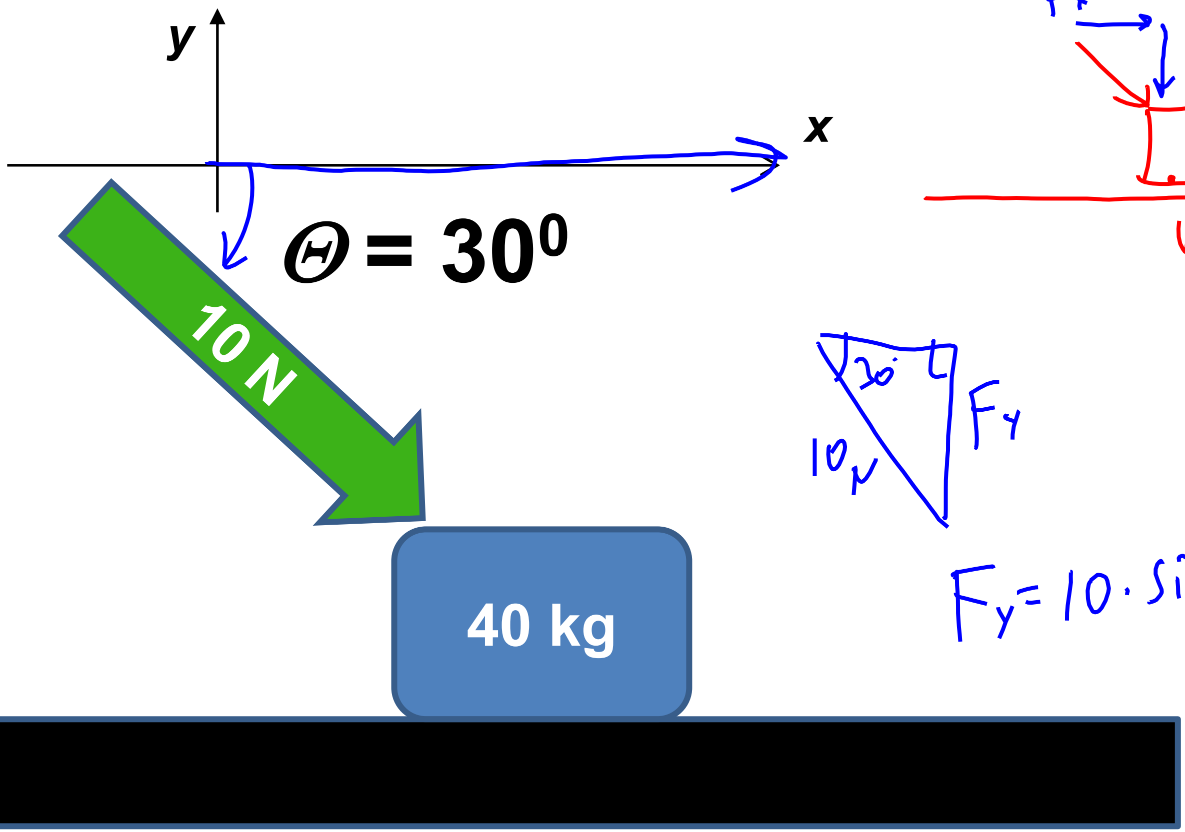
1. $|N| = 400$ N
2. $|N| > 400$ N
3. $|N| < 400$ N

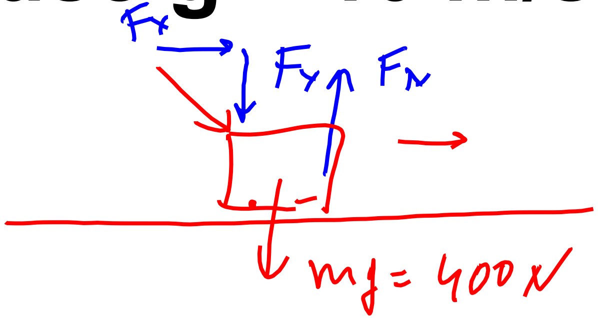
Similar to



Calculate the normal force when an additional force is acting on the box at 30^0 to the horizontal direction (use $g = 10\ m/s^2$).

$\phi = a_y$





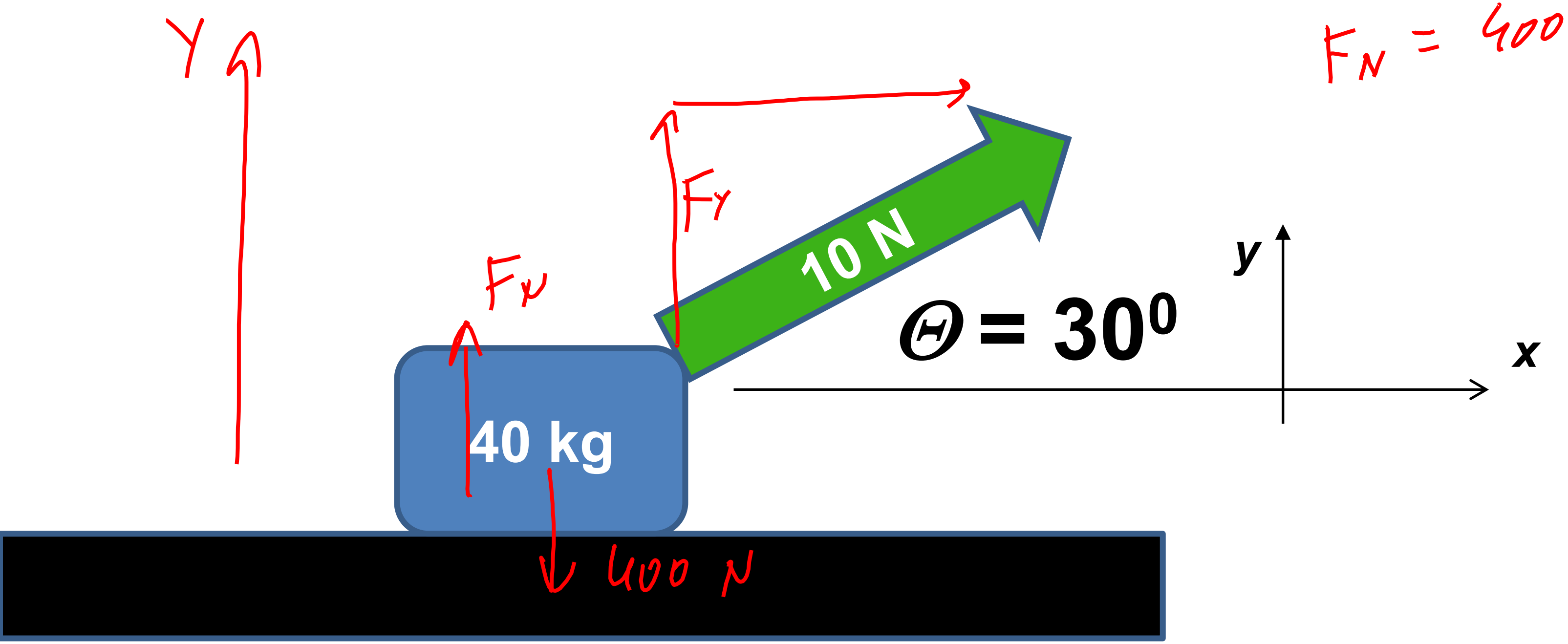
y: $F_N - F_y - mg = m \cdot \phi$

$F_N = mg + F_y$

$F_y = 10 \cdot \sin 30° = 5N$

$F_N = 400 + 5 = 405\ N$

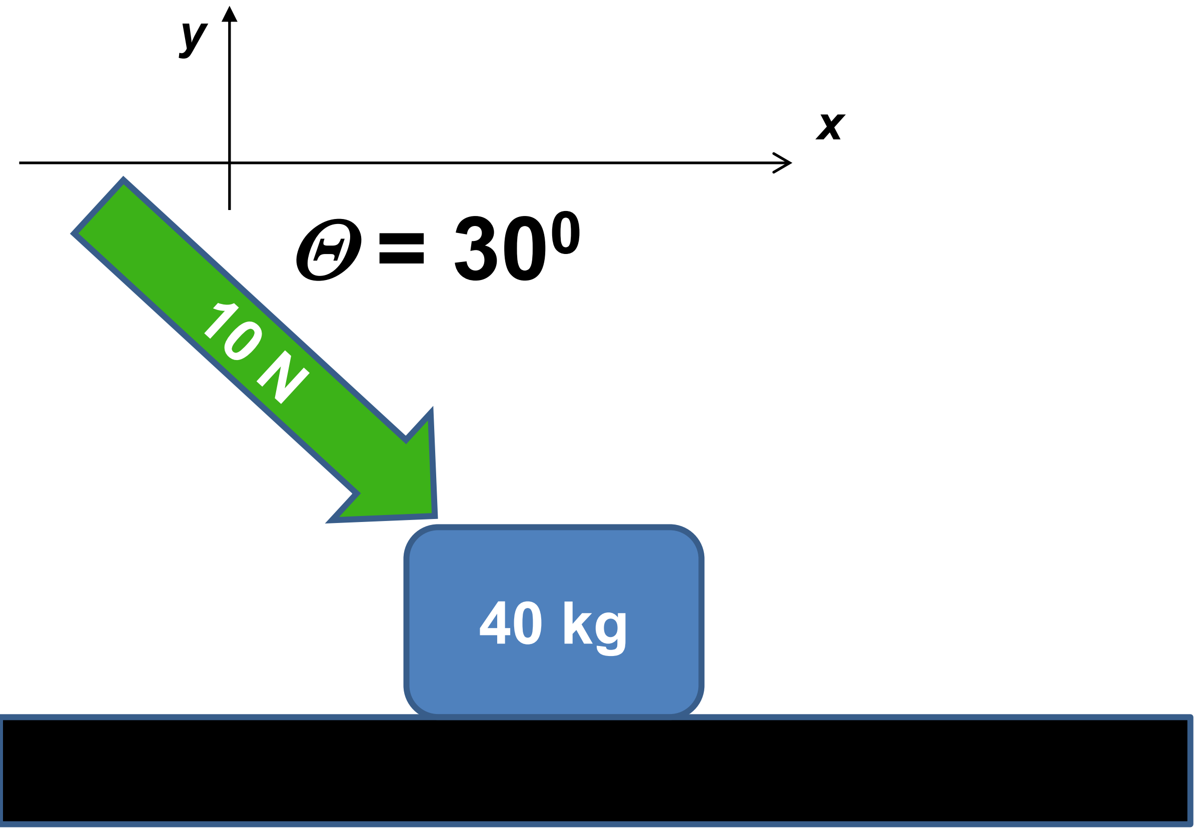
Calculate the normal force when an additional force is acting on the box at 30^0 to the horizontal direction (use $g = 10\ m/s^2$).



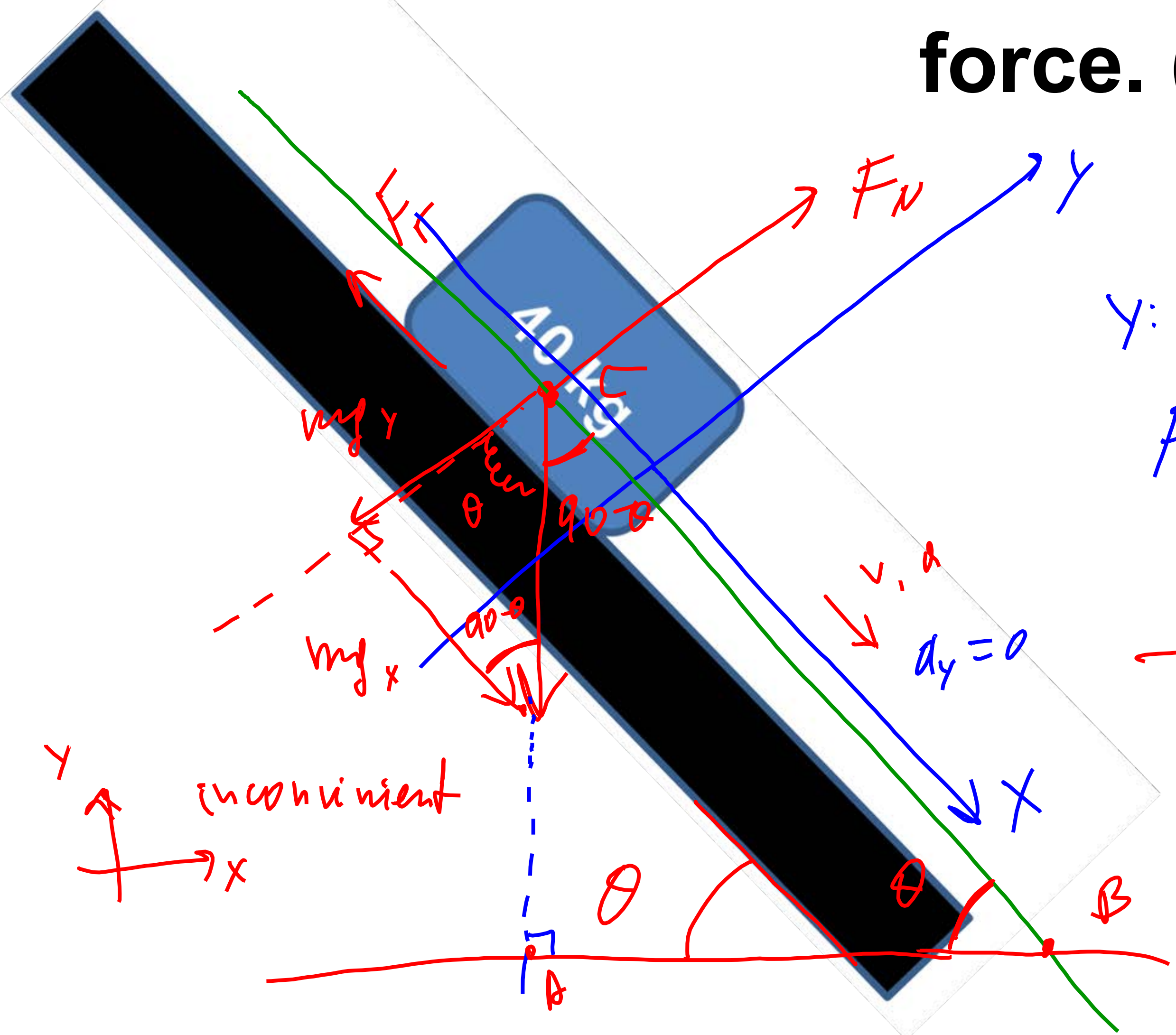
$F_N + F_y - 400 = 0$

$F_N = 400 - 5 = 395\ N$

Calculate the normal force when an additional force is acting on the box at 30^0 to the horizontal direction (use g = 10 m/s^2).



Calculate the normal force. (use g = 10 m/s²).



$F_N = F_y$

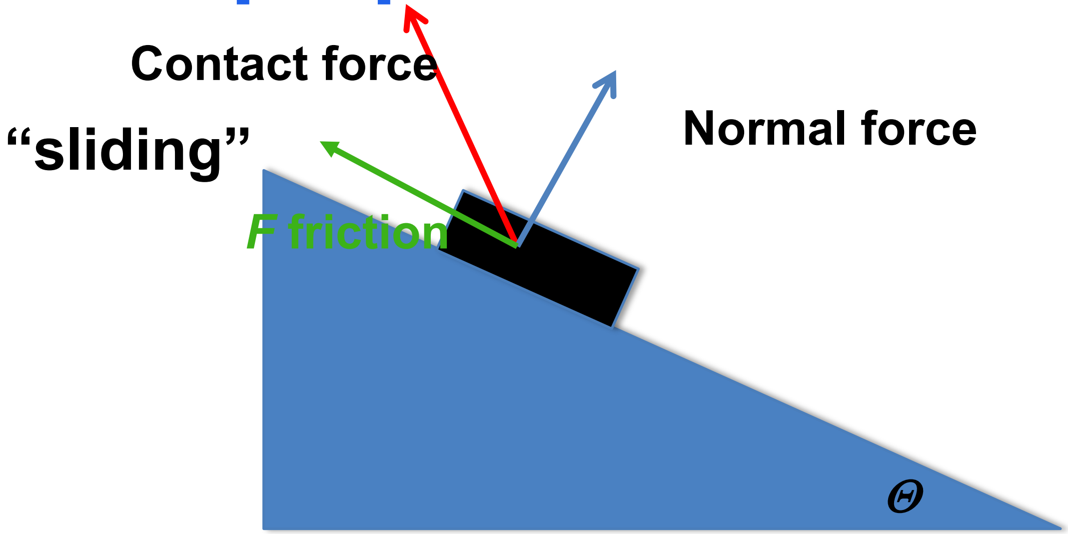
$y: \sum \vec{F} = m \cdot \vec{a}$

$F_N - mg_y = m \cdot 0$

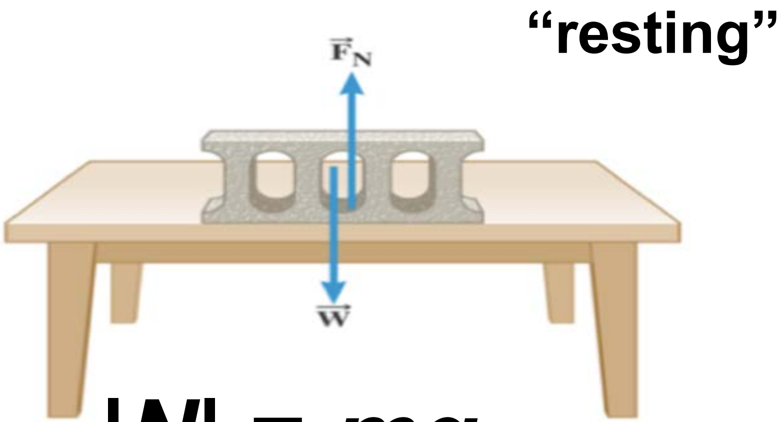
$F_N = m \cdot g_y = m \cdot g \cdot \cos\theta$

An official definition of a **normal force:**

It is a component of a contact force which is perpendicular to a surface.



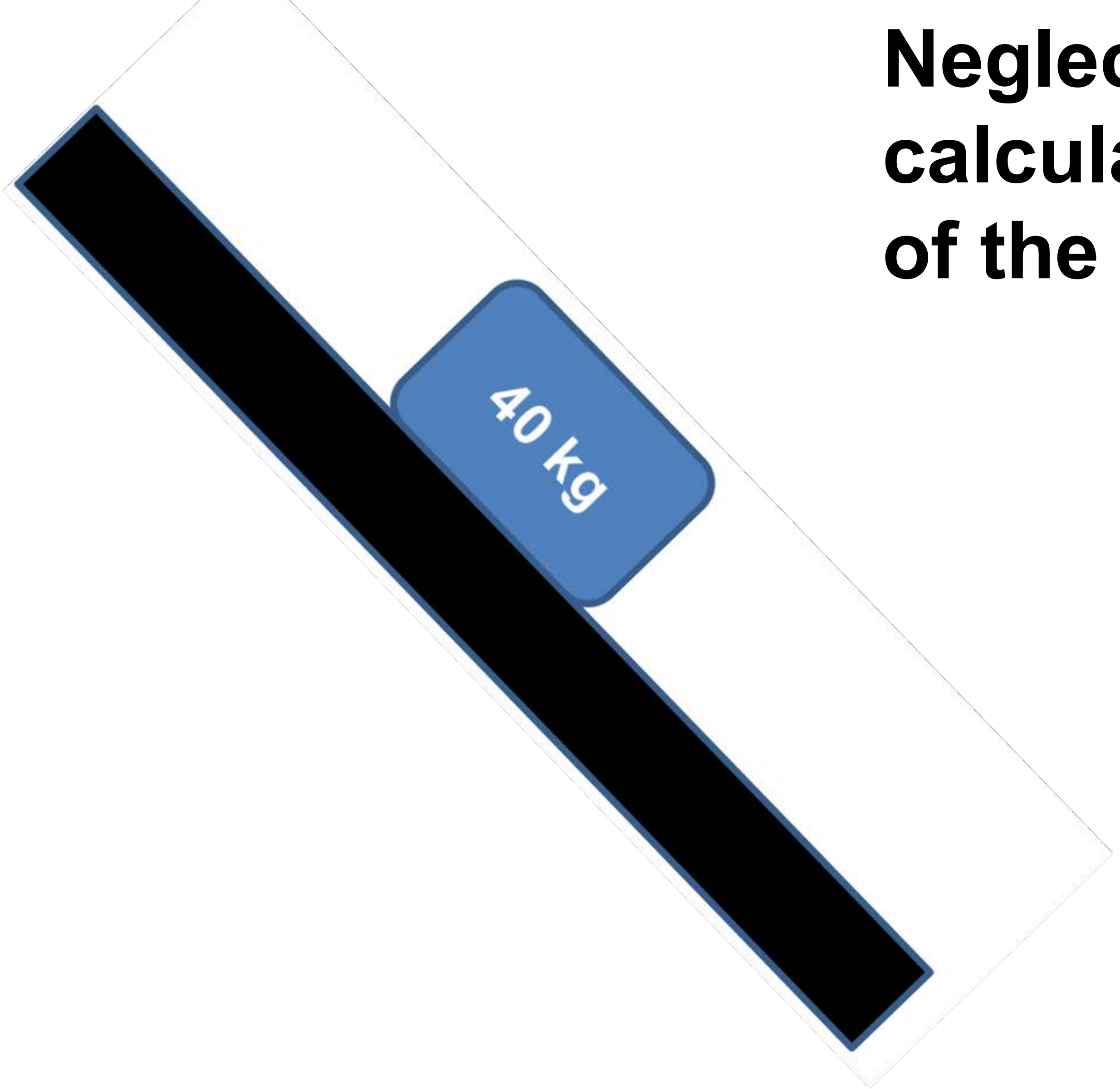
Normal force is equal to whatever N2L makes it to be equal to.



$$|N| \neq mg$$

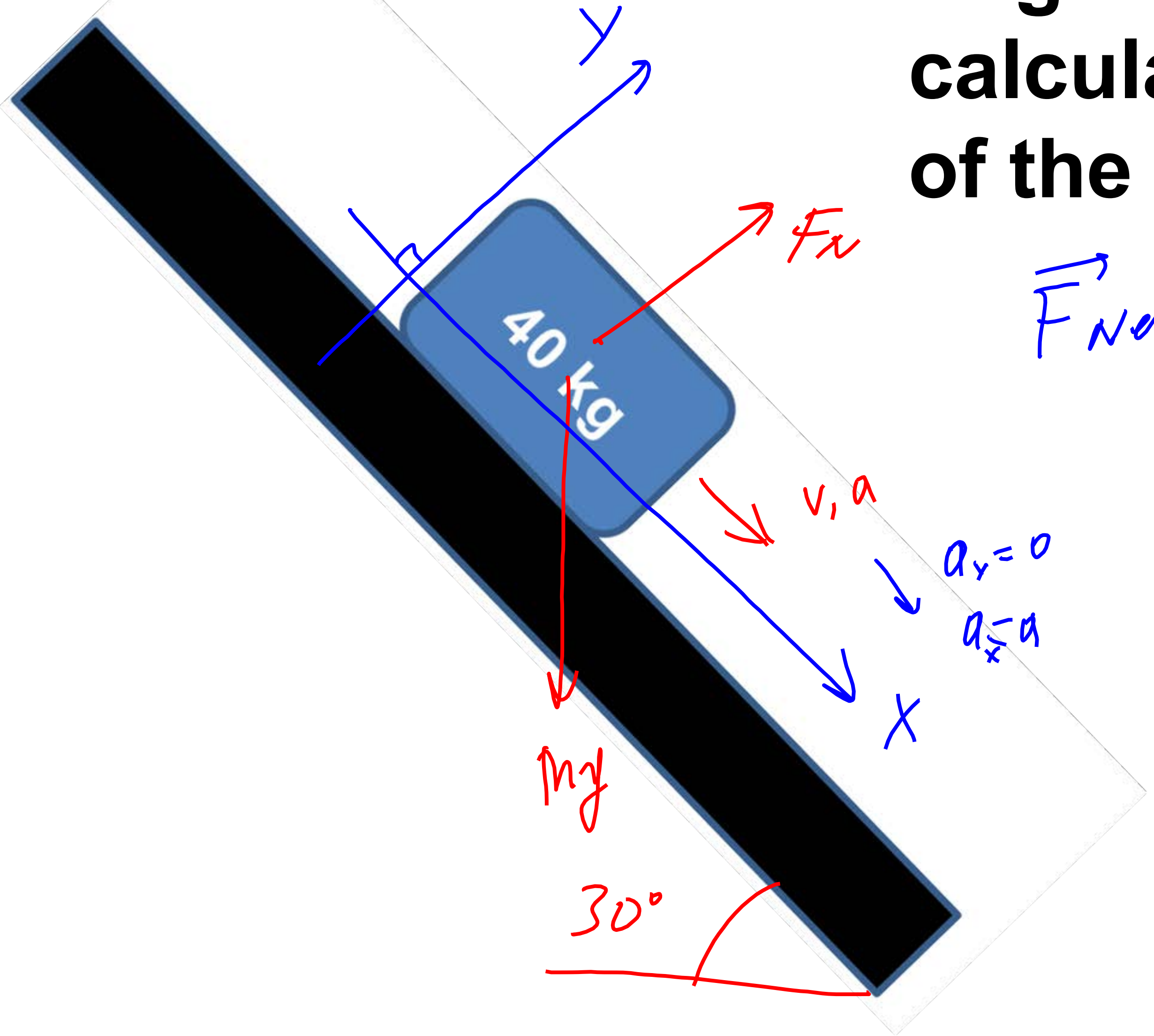
$$|N| = m*g*\cos\Theta$$

$$|N| = mg$$



Neglect friction and calculate the acceleration of the box.

Neglect friction and calculate the acceleration of the box.



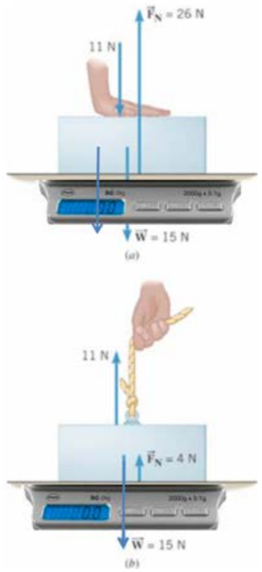
$\vec{F}_{Net} = m \cdot \vec{a}$;

x: $mg_x + 0 = m \cdot a_x$

y: $F_N = mg\cos\theta$

$g_x = a$

$a = g \cdot \sin\theta$



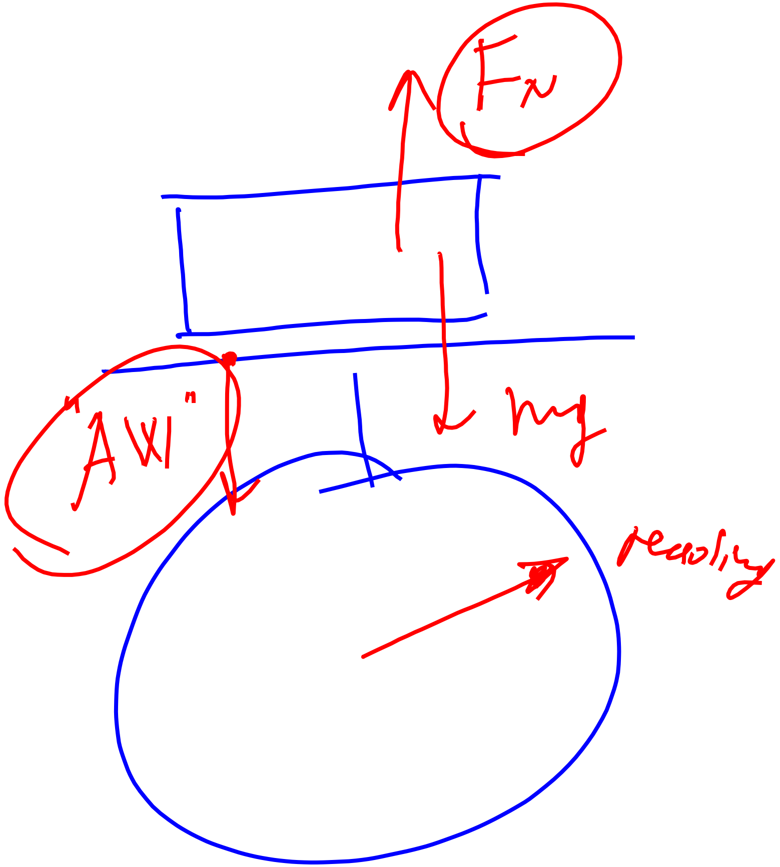
"Measured" weight;

$|W_M| = |N|$

(a.k.a. a scale reading)

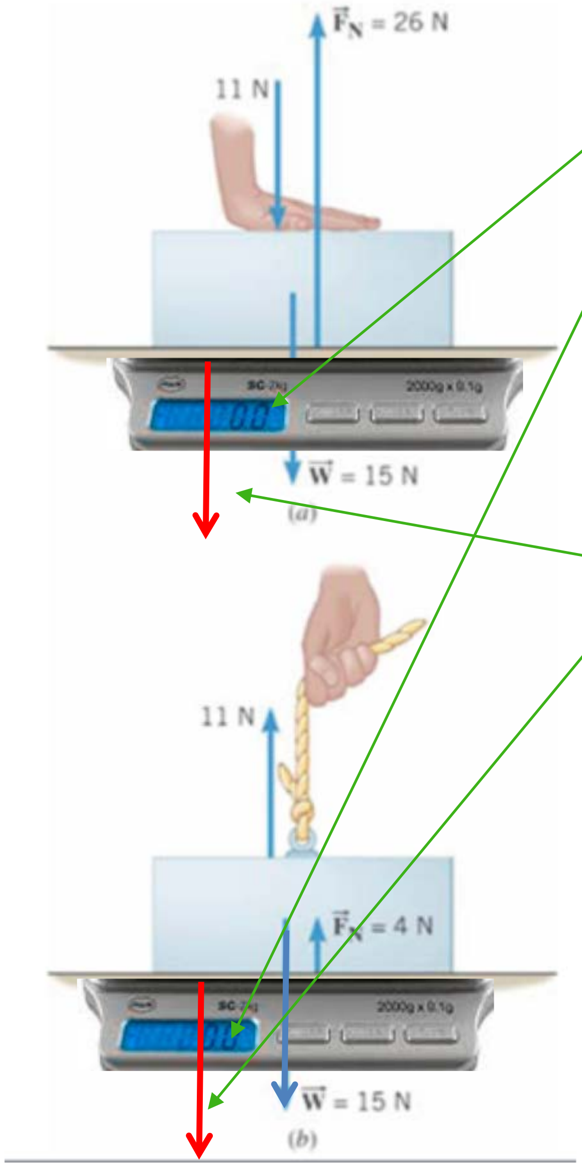
Apparent weight;

$\vec{W}_A = (-1) \cdot \vec{N}$ ("from an object on a support or a suspension")



$MW = |F_N| = |AW|$

N3L



"Measured" weight;

$|W_M| = |N|$

(a.k.a. a scale reading)

Apparent weight;

$\vec{W}_A = (-1) * \vec{N}$ **("from an object on a support or a suspension")**

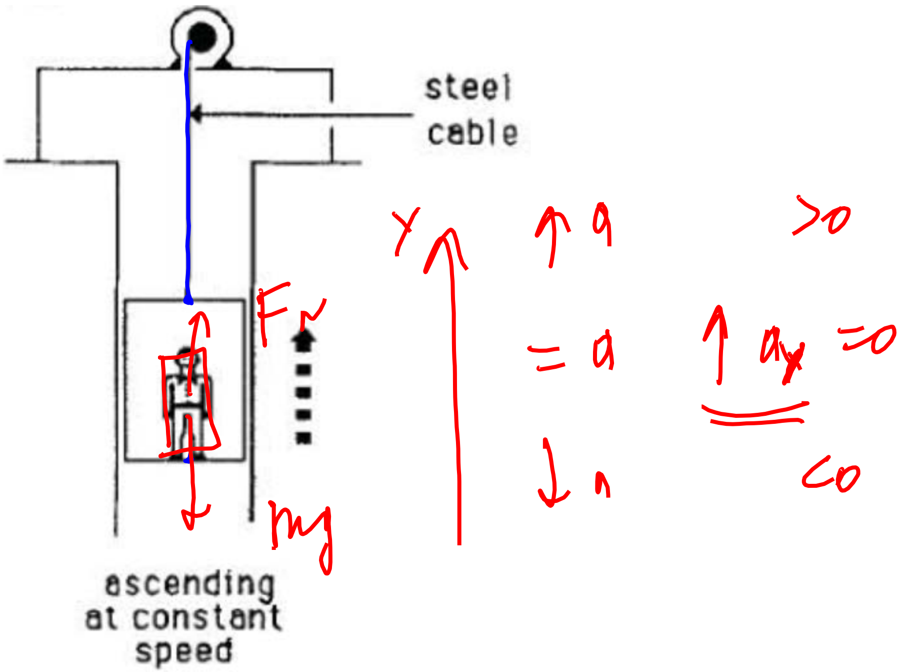
Apparent weight;

$W_A = (-1)*N$

The force acting from an object on a support or a suspension.

The apparent weight of an object does NOT act on the object! It acts FROM the object!

Elevator Physics



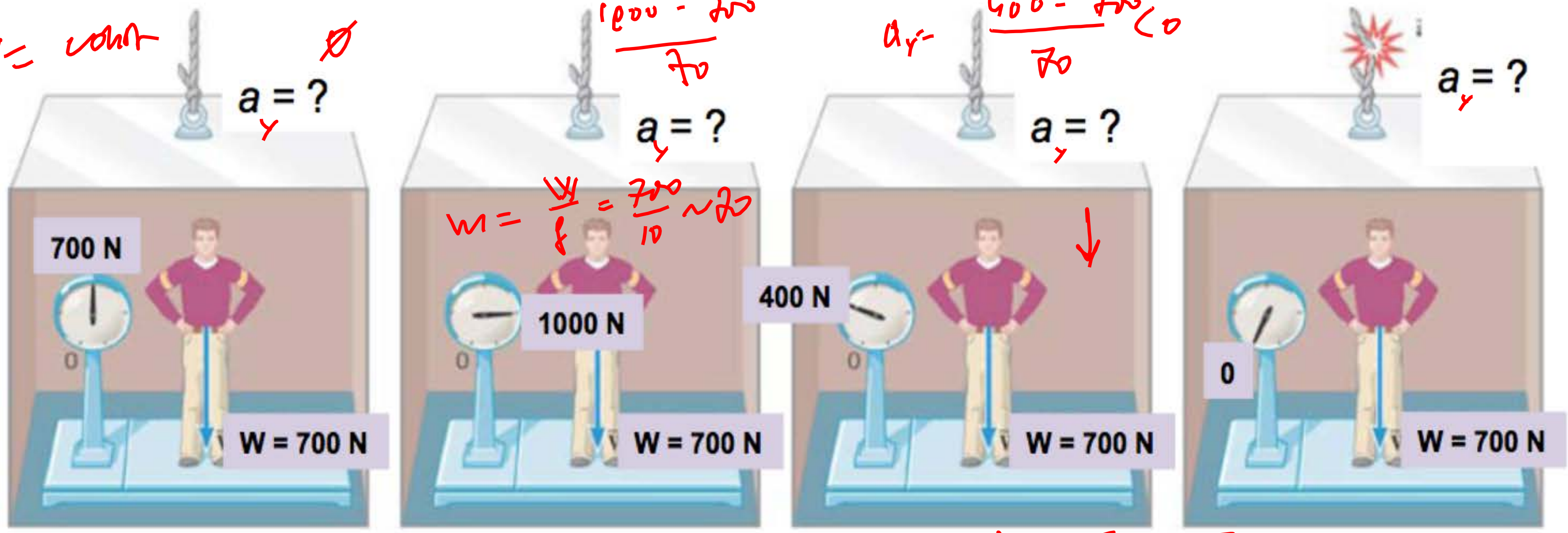
$$F_N - mg = m \cdot a_y$$

$$F_N = mg + m \cdot a_y$$

$$|AW| = |MW| = \text{reading} = m \cdot (g + a_y) = m(g \pm a)$$

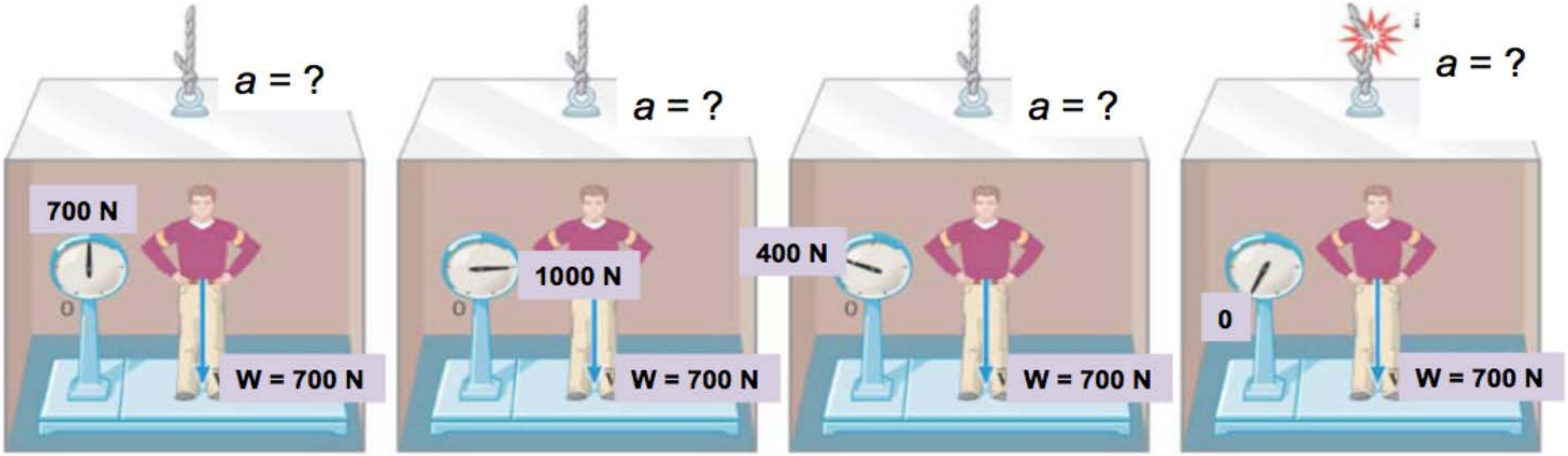
Apparent weight; $W_A = (-1)*N$ (from an object on a support)

"Measured" weight; $|W_M| = |W_A|$ (a scale reading)



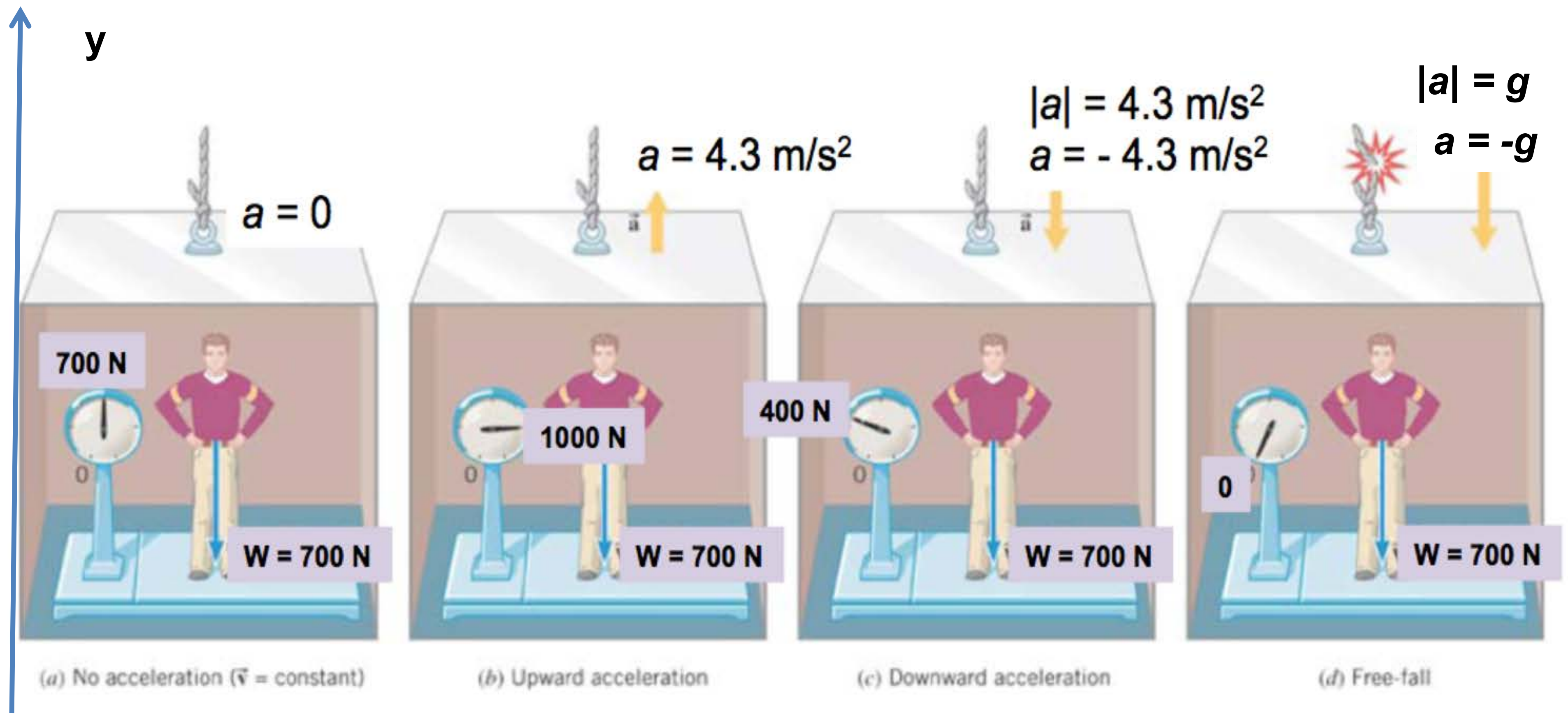
For four different situations shown above, find the acceleration of the elevator.

$F_N = m(g + a_y)$



$$0 = 700 + 70 \cdot a_y$$

$$a_y = -\frac{700}{70} = -g$$



y
a = 0
a = 4.3 m/s²
|a| = 4.3 m/s²
a = - 4.3 m/s²
|a| = g
a = -g
700 N
1000 N
400 N
0
W = 700 N
W = 700 N
W = 700 N
W = 700 N
(a) No acceleration (v⃗ = constant)
(b) Upward acceleration
(c) Downward acceleration
(d) Free-fall

Mass is a measure of ***Inertia.***

Inertia is the property of an object to keep its current state (i.e. its *velocity*).

More MASS => harder change the velocity!

Do you agree that

If $\vec{F}_{net} = 0$ hence the object is definitely at rest?

1. Yes

2. No

$$\vec{\mathbf{a}} = \frac{\sum \vec{\mathbf{F}}}{m}$$

Mass is **a measure of** ***Inertia.***

Inertia **is the property of an object to keep its current state (i.e. its *velocity*).**

<u>More MASS => harder change the velocity!</u>

Do you agree that

If $\vec{F}_{net} = 0$ hence that object is <u>definitely</u> at rest?

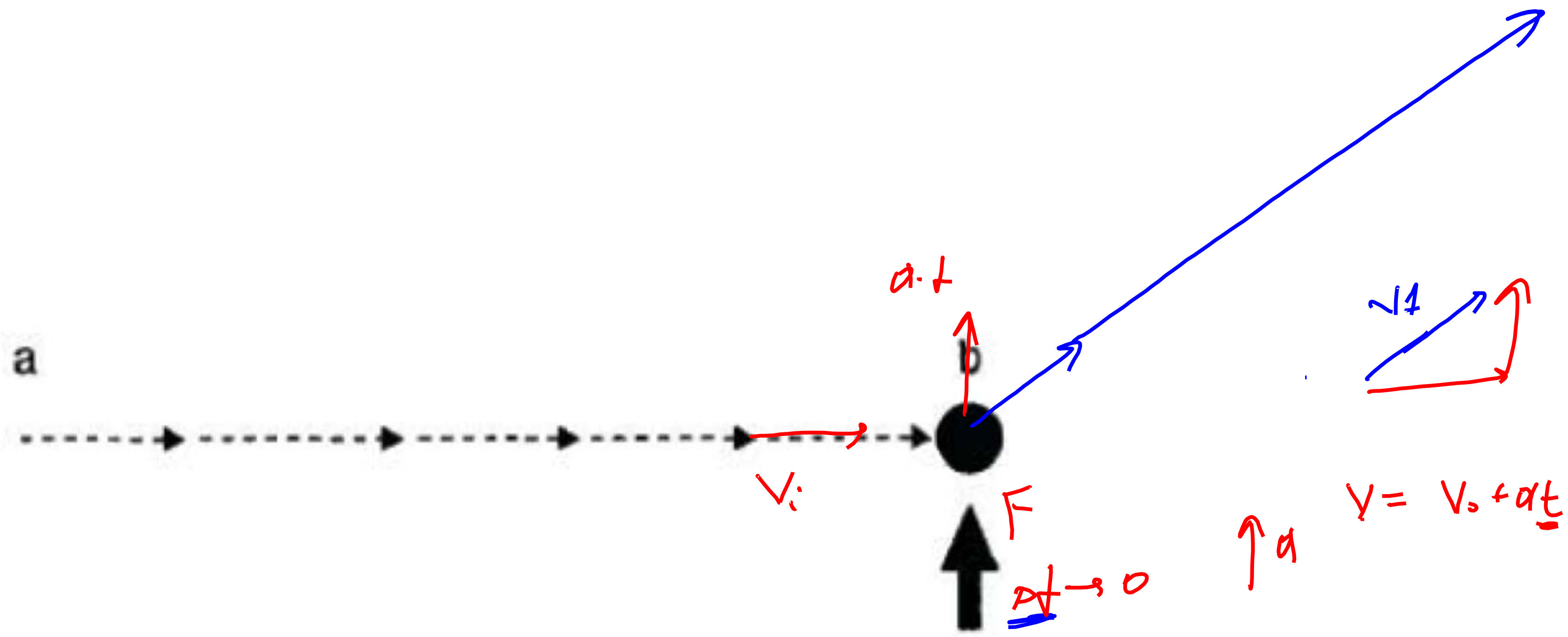
~~1. Yes~~ ***2. No***

$\vec{F}_{net} = 0 \quad \Rightarrow \quad a = 0 \quad \Rightarrow \quad v = const \; !$

Newton's First Law

An object does NOT need a force in order to be kept at rest or in a state of a linear motion with a constant velocity. $\vec{a}$

In order to *change its velocity* an object must be under action of at least one an uncompensated force. $\vec{F}$

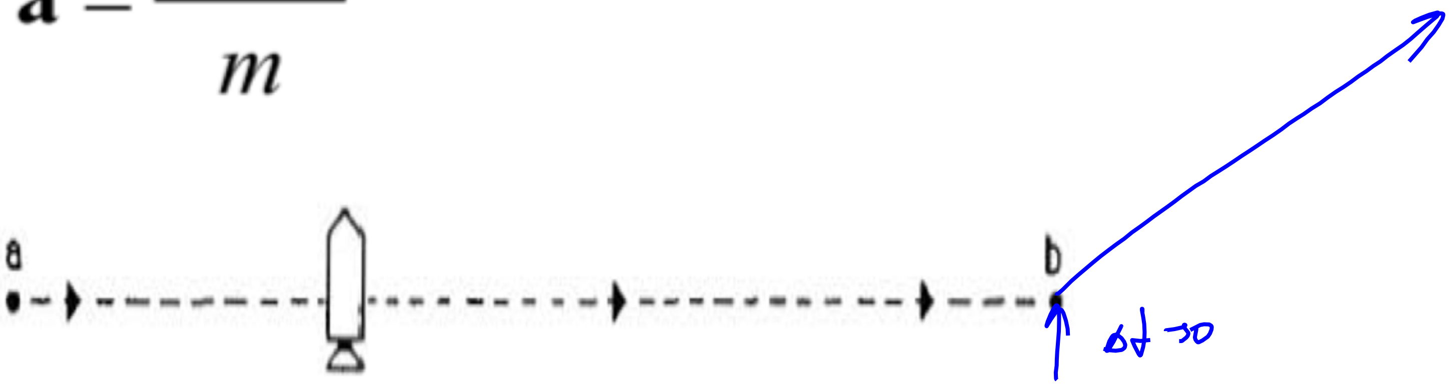


$$0 \neq \vec{a} = \frac{\sum \vec{F}}{m}$$

A drifting puck receives a "kick" at point B. What happens next?

Is this problem different from the previous one? 1. yes 2. no

$$\vec{a} = \frac{\sum \vec{F}}{m}$$

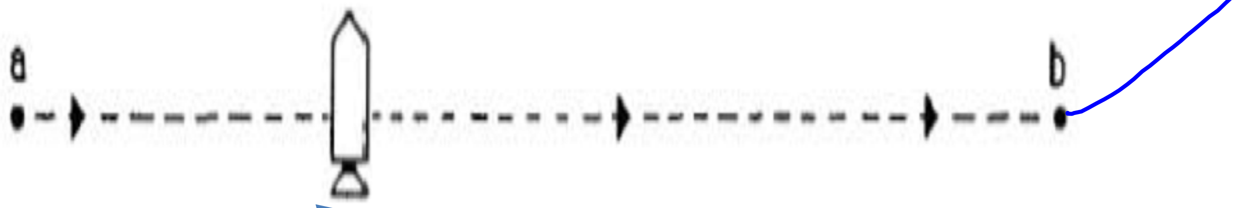


A rocket is drifting in outer space. At "b", the rocket's engine makes a quick burst of a thrust at right angle to line "ab". What happens next?

$$\vec{a} = \frac{\sum \vec{F}}{m}$$

Is this problem different from the previous one? Yes

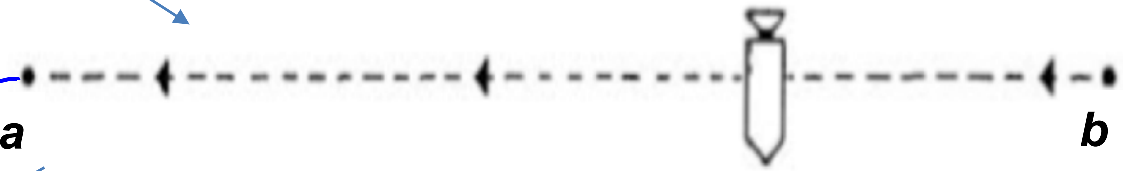
A rocket is drifting in outer space. At "b", the rocket's engine starts to produce a constant thrust at right angle to line "ab". The engine turns of again as the rocket reaches some point "c".



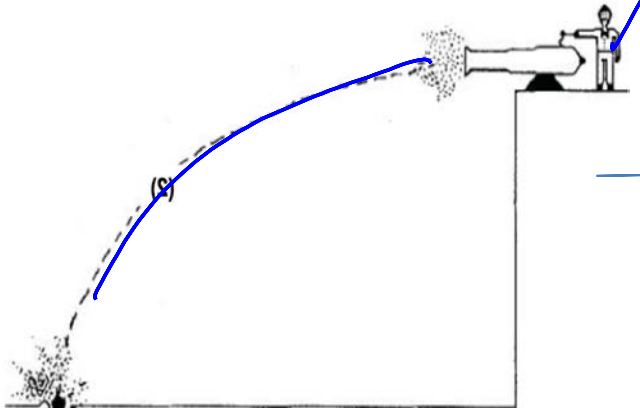
$$\vec{a} = \frac{\sum \vec{F}}{m}$$

This case is equal to this (if you look at it upside down)

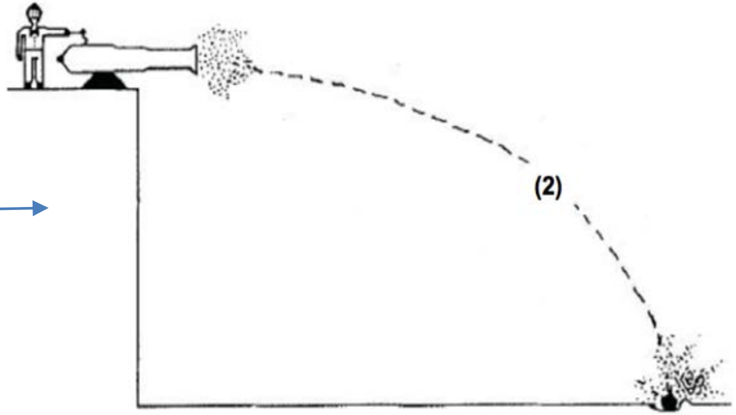
Constant thrust = Constant force



or



or

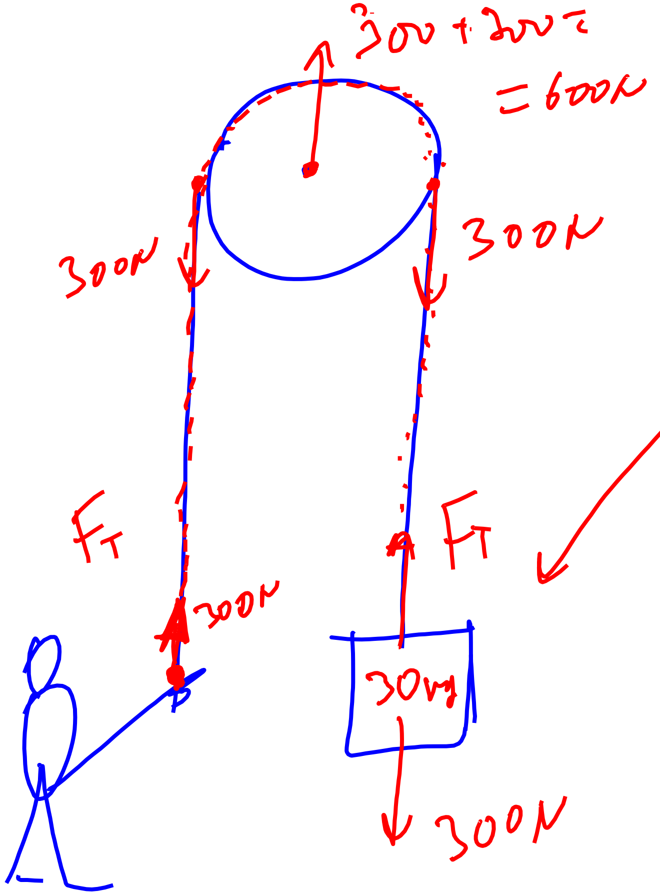


DONE with the exam 1 material!

Bring to the exam: a calculator, a pen/pencil, an eraser, a ruler, an ID

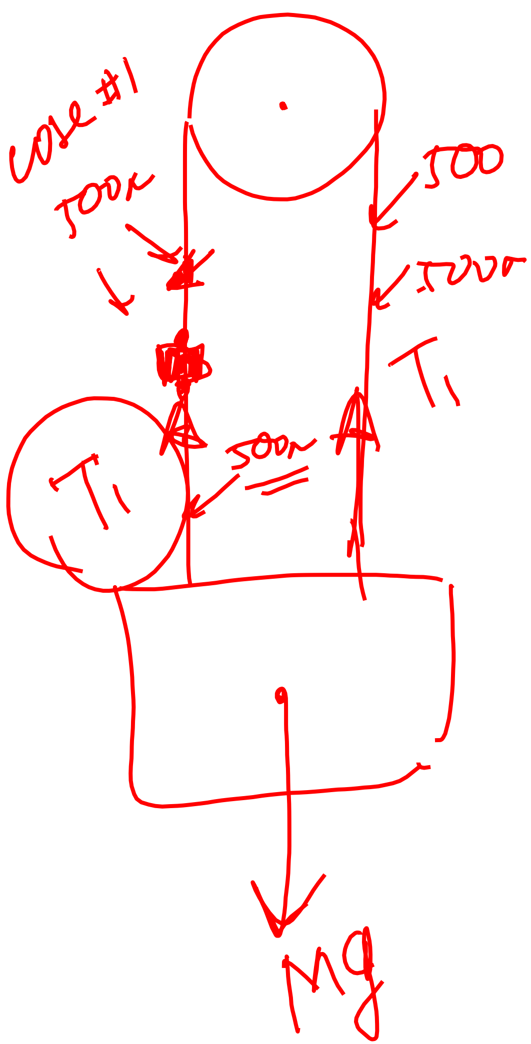
Q &A

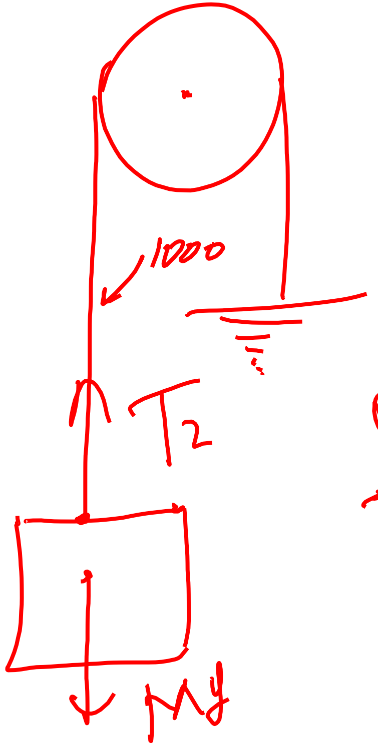
Hide in the backpack: a phone, a case from a calculator, paper, books, notebooks, anything else



$V = const \Rightarrow a = 0 \Rightarrow$ or rest

$F_{net} = 0 \Rightarrow F_T = 300N$



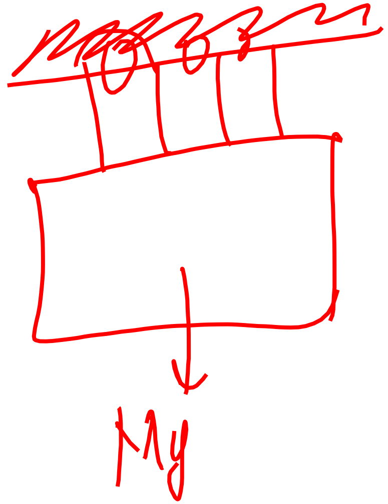


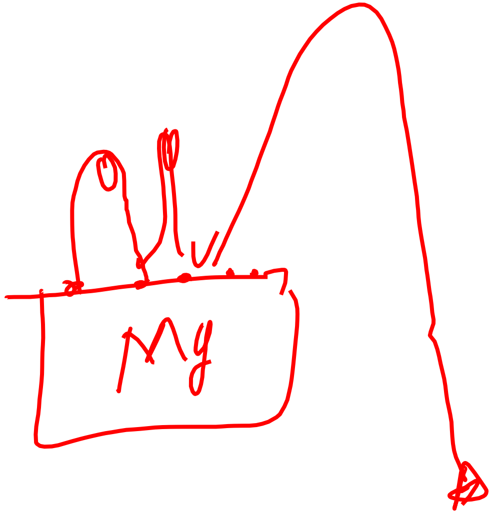
$$T_1 + T_1 = Mg$$

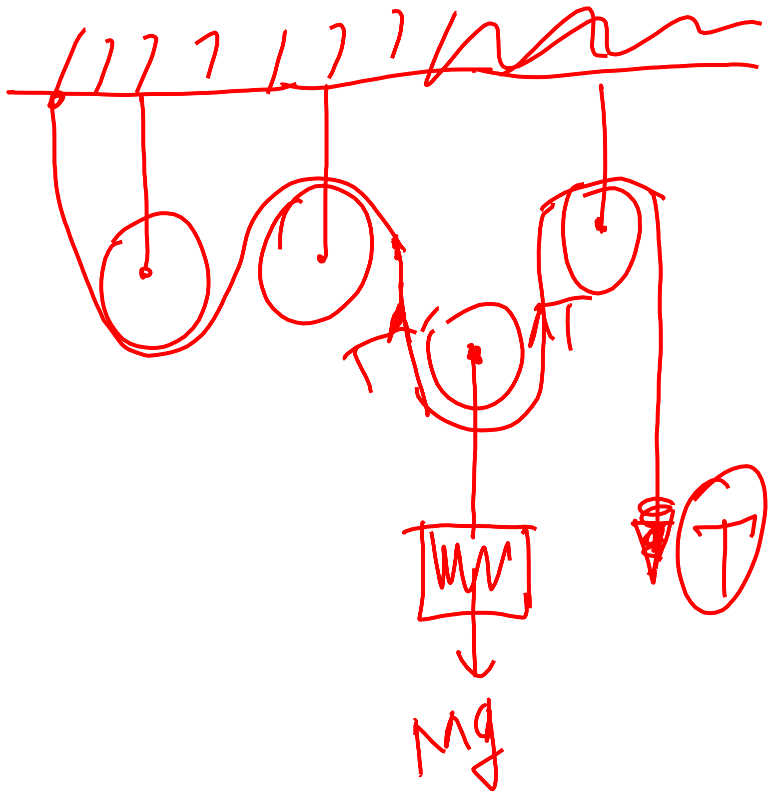
$$2 \cdot T_1 = Mg$$

500N

$$T_2 = Mg = 2 \cdot T_1$$






T
T
T
Mg