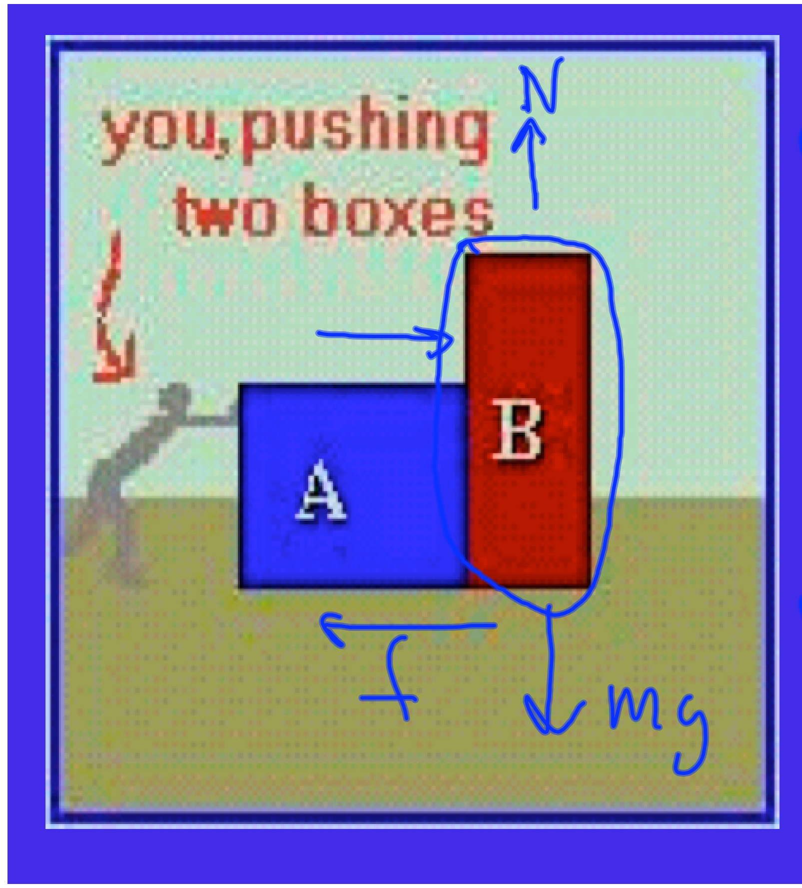
Reminders 07-20-09:

- 4th Webassign due Tomorrow 11:59PM
- Turn in Vector Addition Worksheet
- Hand in 3rd Assignment Problem Today
- ***Exam 2 Chapters 4-5 Wed or Thurs.***
- 5th Webassign Ch 6 Due Wednesday
- Pick Up Graded Assignment in Box Outside My Office

Objectives:

- Free Body Diagrams
- Examples



① Force of A on B

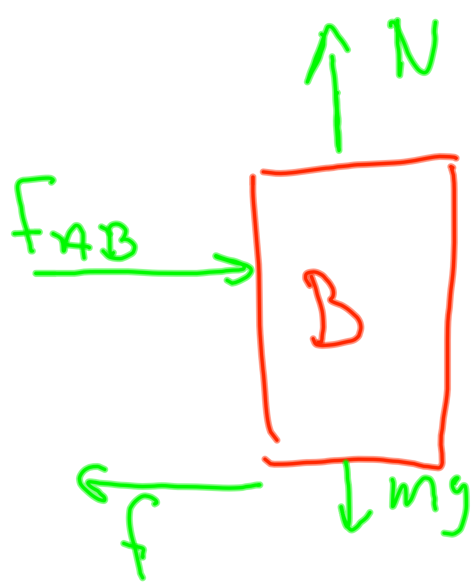
F_{AB}

② Force of ground on B, N.

③ Force of Earth on B, $m_B g$.

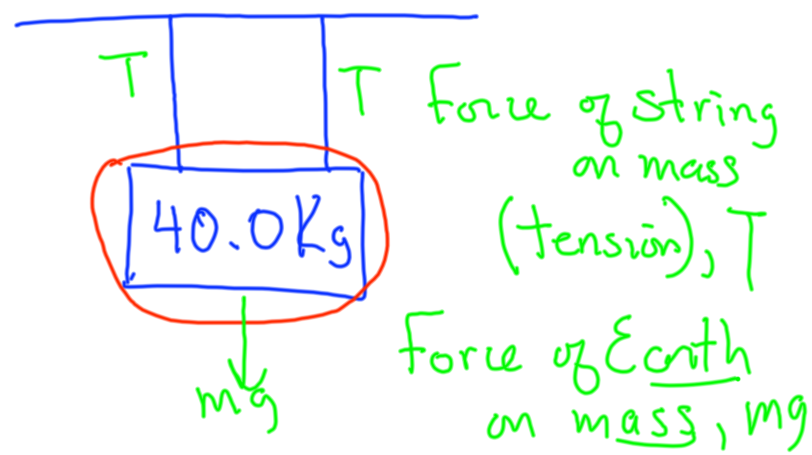
2 & 3 are NOT action reaction pairs

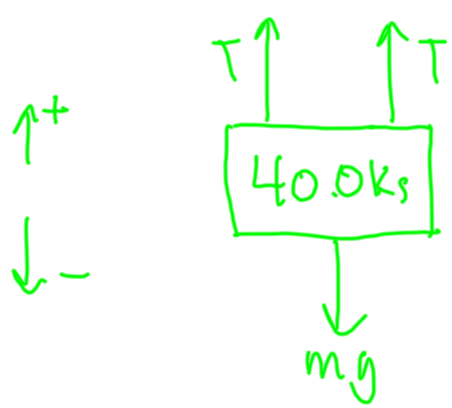
④ frictional force of ground on B, f



free-body diagram

Two strings are attached to a ceiling of a room to support a 40.0 kg mass. If you denote the tension in the string by T find the tension in the strings?





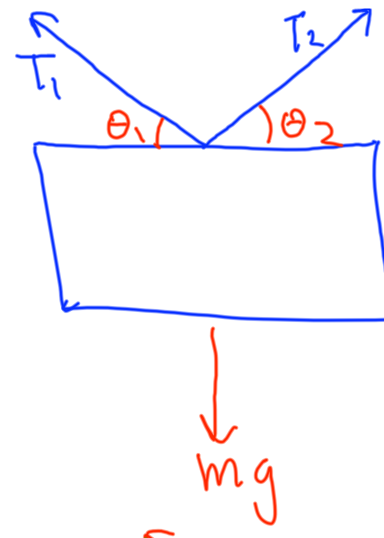
$$\Sigma F_y = T + T - mg = 0$$

$$2T - mg = 0$$

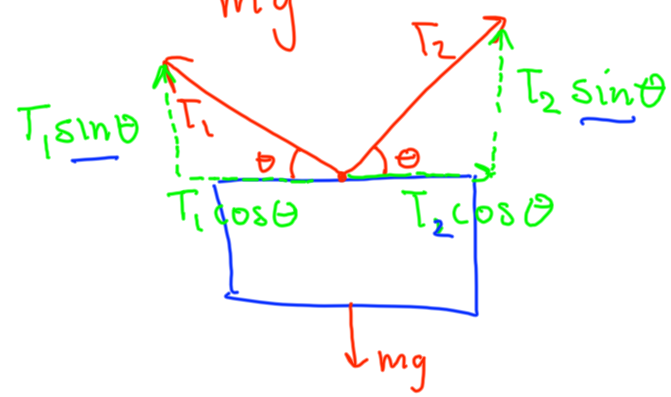
$$2T = mg$$

$$T = \frac{mg}{2} = \frac{(40.0\,\text{kg})(9.80\,\frac{m}{s^2})}{2}$$

$$= \underline{196\,N}$$



let $\theta_1 = \theta_2$



$$\Sigma F_x = -T_1\cos\theta + T_2\cos\theta = 0$$

$$T_1 \cancel{\cos\theta} = T_2 \cancel{\cos\theta}$$

$$T_1 = T_2 = T$$

$$\Sigma F_y = 2T\sin\theta - mg = 0$$

$$2T\sin\theta = mg$$

$$T = \frac{mg}{2\sin\theta}$$

if $\theta = 90$ $\quad T = \frac{mg}{2}$

if $\theta = 0$? not possible

can't cancel a vertical force with a horizontal force

θ_1 & θ_2

$$\Sigma F_x = T_1\cos\theta_1 - T_2\cos\theta_2 = 0$$
$$\Sigma F_y = T_1\sin\theta_1 + T_2\sin\theta_2 - W = 0$$

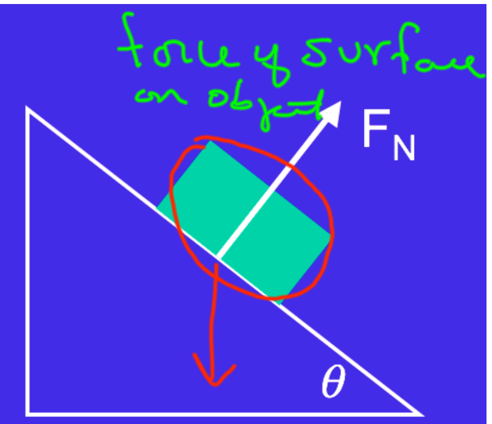
2 equations with 2 ukns

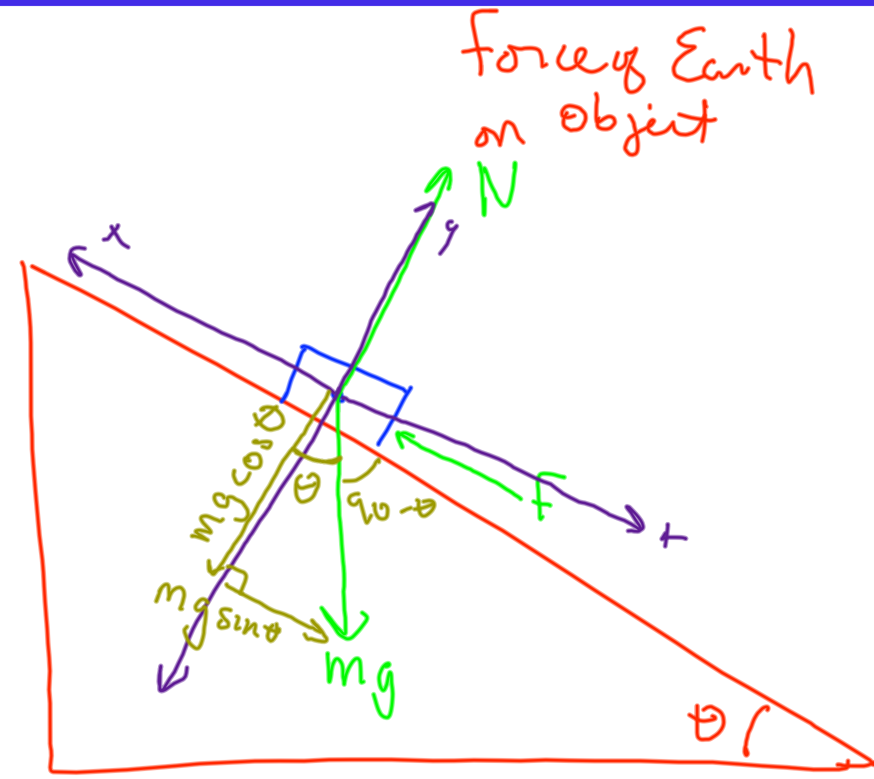
$$T_1\cos\theta_1 = T_2\cos\theta_2$$
$$T_1 = T_2\frac{\cos\theta_2}{\cos\theta_1}$$

$$T_2\frac{\cos\theta_2}{\cos\theta_1}\sin\theta_1 + T_2\sin\theta_2 - W = 0$$
$$T_2\cos\theta_2\tan\theta_1 + T_2\sin\theta_2 = W$$
$$T_2\left[\cos\theta_2\tan\theta_1 + \sin\theta_2\right] = W$$
$$T_2 = \frac{W}{\cos\theta_2\tan\theta_1 + \sin\theta_2}$$

plug values to obtain T_2 and substitute into equation for T_1 to obtain T_1

- **A 1.0x10¹ kg box is on a hill (θ=30.0°). What force is required to keep this block in equilibrium? How can we accomplish this? What is the normal force?**





$$\Sigma F_x = -F + mg\sin\theta = 0$$

$$F = mg\sin\theta$$

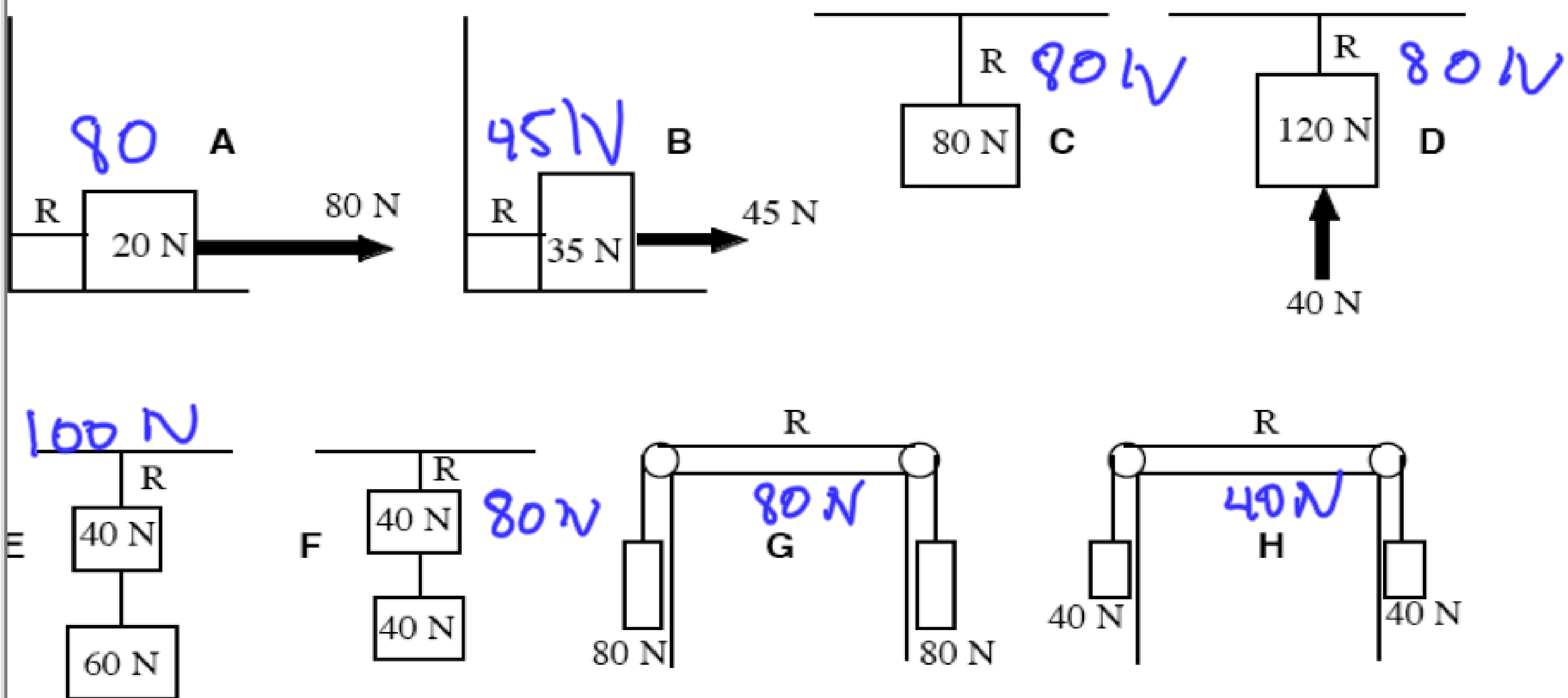
then substitute values

$$\Sigma F_y = N - mg\cos\theta = 0$$

$$N = mg\cos\theta$$

The eight figures below show various situations where blocks of different weights are attached by ropes to rigidly fixed objects or to other blocks, which are attached to fixed objects. The situations differ in a number of ways, as the figures show. The weights of the blocks are given in the figures, as well as the magnitudes and directions of any other forces that may be acting. Our interest is solely in the rope that is designated R in each figure.

Rank these arrangements, from greatest to least, on the basis of the tension in the rope R. That is, put first the arrangement where rope R is under the greatest tension and put last the arrangement where rope R is under the least tension.

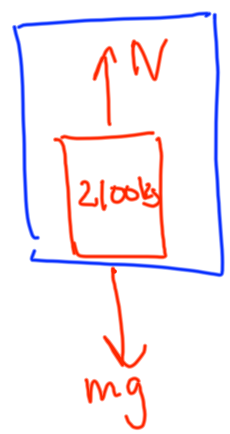


Greatest 1_____ 2_____ 3_____ 4_____ 5_____ 6_____ 7_____ 8_____ Least

Or, all the ropes marked R are under the same tension (but not zero). _______

Or, there is no tension in any of these ropes. _______

- An elephant gets on an elevator. He presses a floor button and notices the force with which the elevator presses up on his feet changes. The elephant has a mass of 2100kg. Just after the button is pressed, the force against his feet is 15,000N.
  - What is the elephant's weight?
  - What is the net force acting on the elephant?
  - What is the elephant's acceleration? Up or down?



$mg = (2100\,kg)(9.80\,\frac{m}{s^2})$

$= 20{,}600\,N$

$\Sigma F_y = N - mg = ma$

$15{,}000\,N - 20{,}600\,N$

$= -5600\,N$

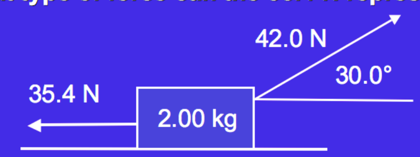
Elephant going down because $N < mg$

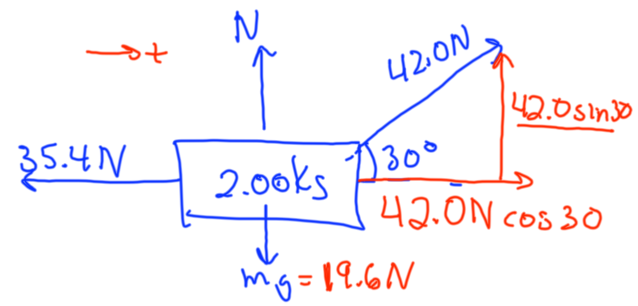
$-5600\,N = ma$

$a = \frac{-5600\,N}{2100\,kg}$

If v = constant then $a = 0$ and $N = mg$, independent of direction of elevator.

- Consider the system shown.
  - Draw a free-body diagram for the system.
  - What is the net force acting on the object?
  - What is its acceleration?
  - What type of force can the 35.4 N represent?





$\Sigma F_x = 42.0\,N \cos 30 - 35.4\,N = ma_x$

$= 36.4\,N - 35.4\,N = 1.0\,N = ma_x$

$a_x = \frac{1.0\,N}{m} = \frac{1.0\,N}{2.00\,kg} = 0.50\,m/s^2$

$\Sigma F_y = N - mg + 21\,N = ma_y$

but $N = 0$ since $N < mg$

$-mg + 21.0\,N = ma_y$

$-19.6\,N + 21.0\,N = ma_y$

$1.4\,N = ma_y$

$a_y = \frac{1.4\,N}{2.00\,kg} = 0.70\,m/s^2$

$a_x = 0.50\,m/s^2 \quad a_y = 0.70\,m/s^2$

what is $|\vec{a}|$?

$|\vec{a}| = \sqrt{(.50\,\frac{m}{s^2})^2 + (.70\,\frac{m}{s^2})^2} = 0.86\,\frac{m}{s^2}$

$\theta = \tan^{-1}\left(\frac{.70}{.50}\right) = 54°$ above x-axis

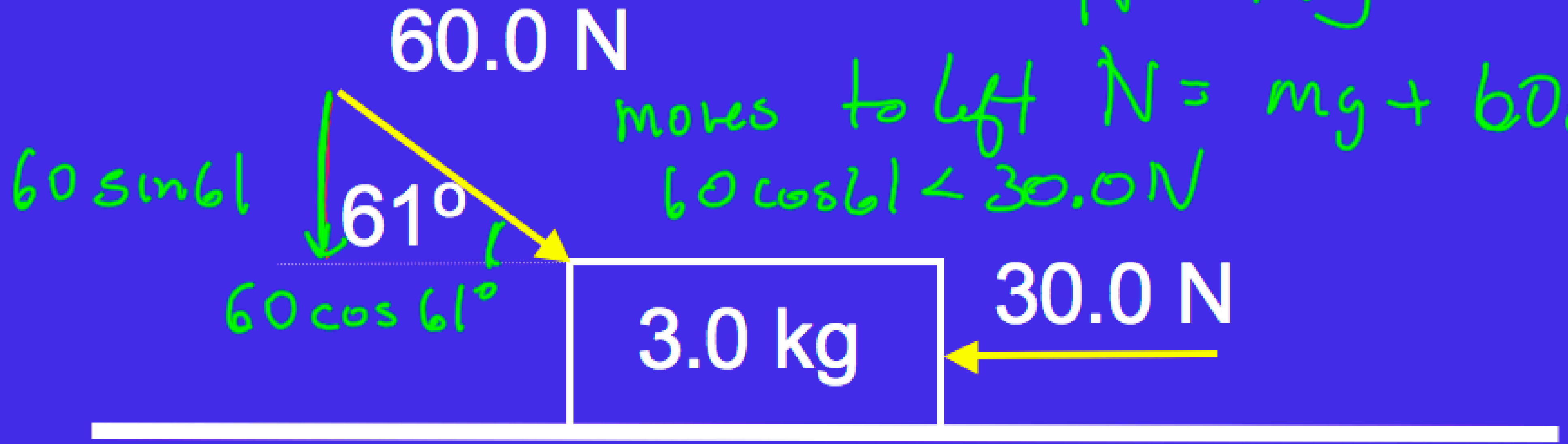
Examples

- **Newton's 2nd Law**
  - What is the net force acting on the block? What is its acceleration? Normal force?

N > mg

moves to left N = mg + 60sin61

60cos61 < 30.0N



Examples

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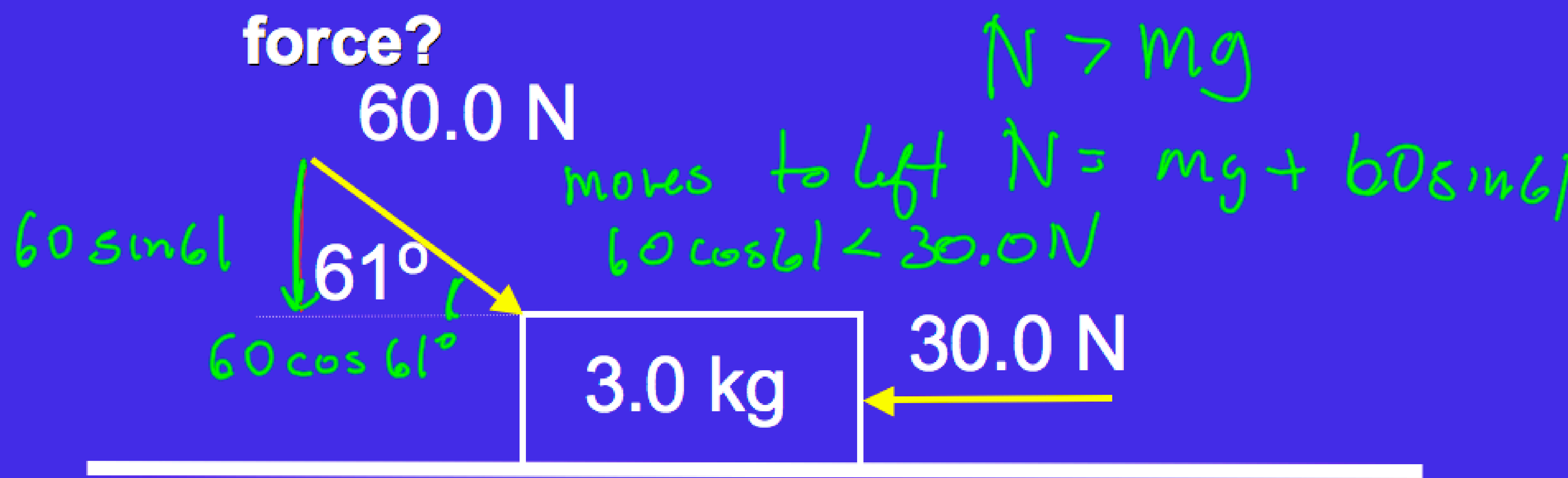
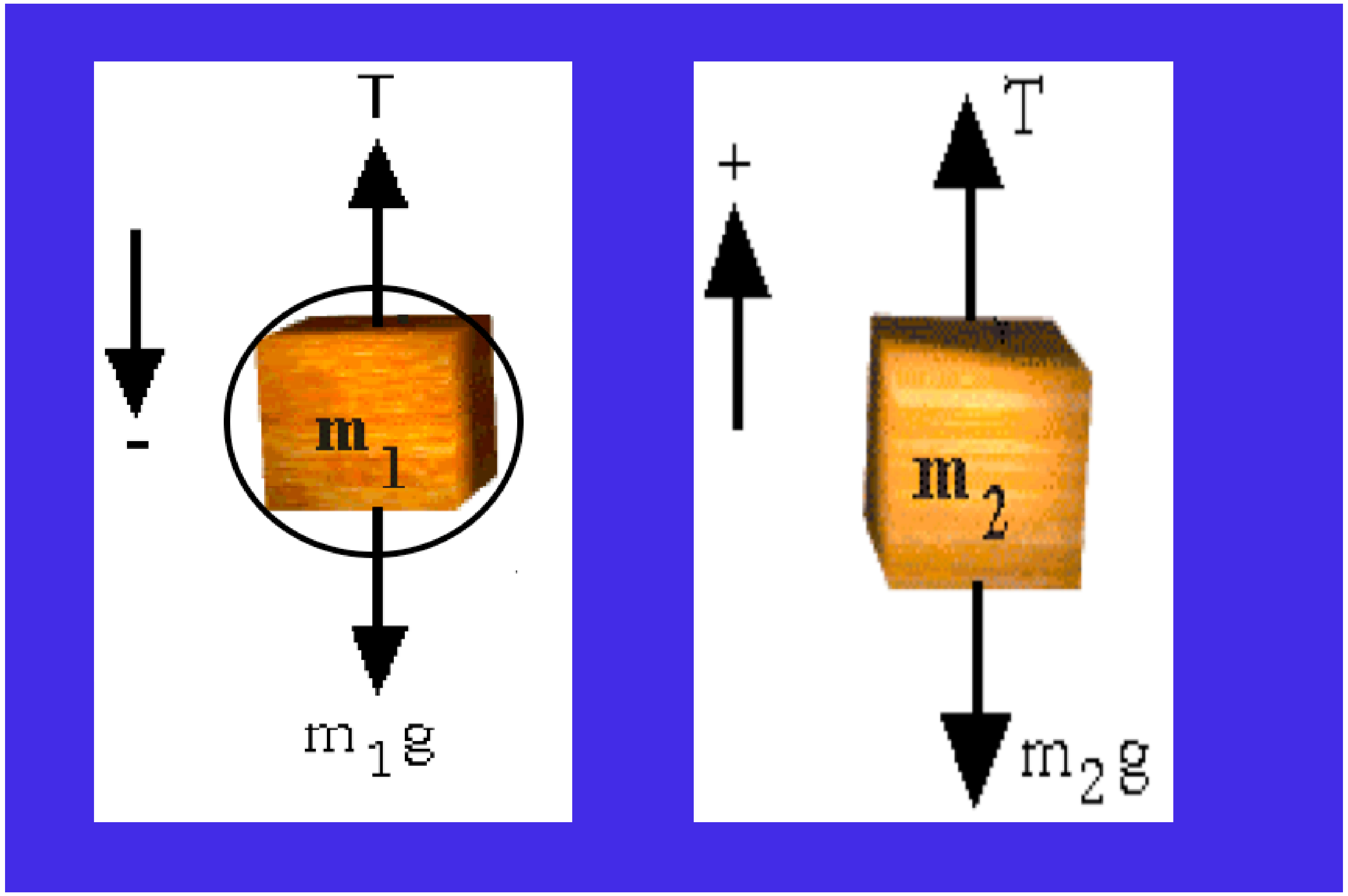
  - **What is the net force acting on the block? What is its acceleration? Normal force?**



Ans: 0.9 N to left; 0.3 m/s² to left; 82 N



let $m_1 > m_2$

$$\Sigma F_{m_1} = T - m_1 g = -m_1 a$$

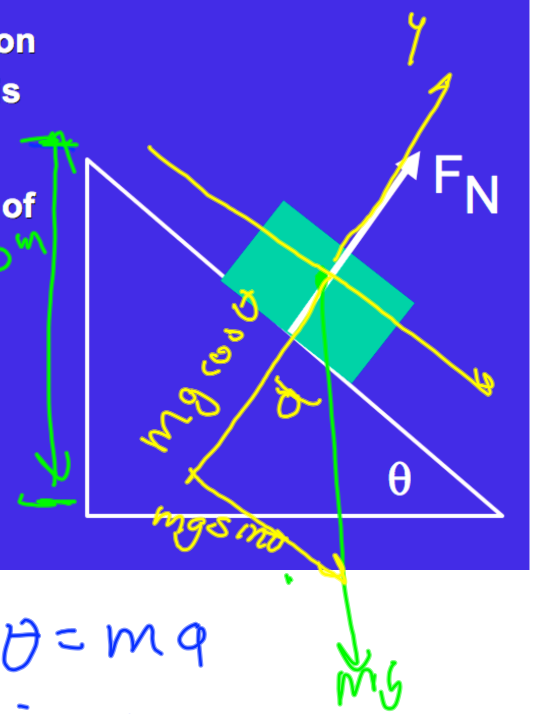
$$\Sigma F_{m_2} = T - m_2 g = +m_2 a$$

solve for a

$$a = \frac{(m_1 - m_2)g}{m_1 + m_2}$$

Examples

- A 1.0 kg mass is placed on a frictionless plane that is inclined at 30.0 degrees.
- What is the acceleration of the mass?
  - If the incline is 3.0m high how long does it take to reach the bottom?
  - *Answers: 4.9m/s^2; 1.6 s*



$$\Sigma F_x = mg\sin\theta = ma$$

$$a = g\sin\theta = \left(9.80\,\frac{m}{s^2}\right)\sin 30 = 4.9\,m/s^2$$

$$\Delta x = v_i t + \frac{1}{2}at^2$$

$$\Delta x = \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2\Delta x}{a}}$$

$$\frac{O}{h} = \sin\theta \qquad h = \frac{O}{\sin 30}$$

$$h = \frac{3.0\,m}{\sin 30} = 6.0\,m$$

$$t = \sqrt{\frac{2(6.0\,m)}{4.9\,m/s^2}} = \underline{1.6\,s}$$

What does a position vs. time graph look like for the case where the net force acting on an object is constant? What about velocity vs. time?