things not to forget when solving problems

Second law extended form

$$\vec{F}_{net} = m\vec{a},$$

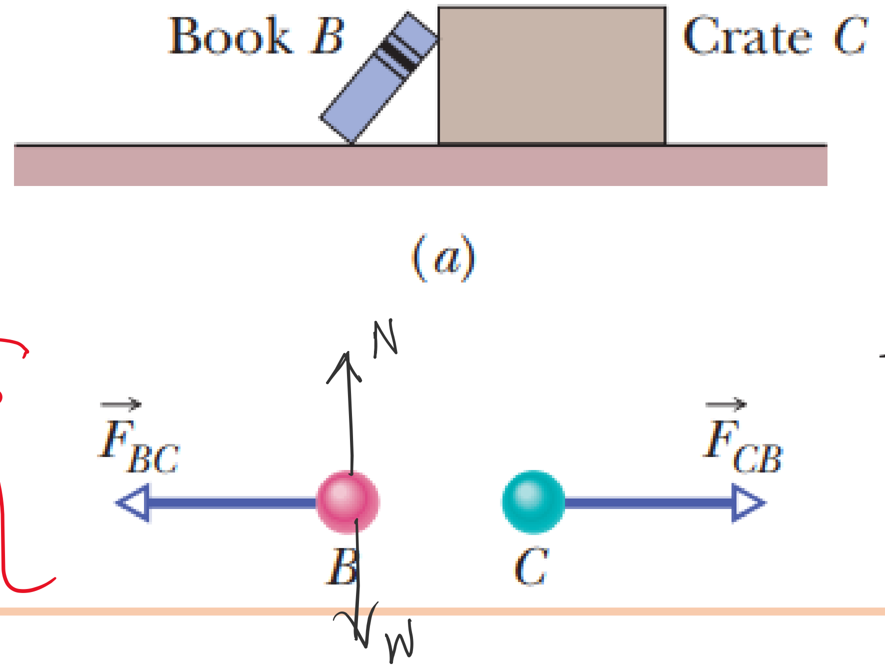
Remember, this represents the net motion. Experiments will tell you the net motion.

which may be written in the component versions

$$F_{net,x} = ma_x \quad F_{net,y} = ma_y \quad \text{and} \quad F_{net,z} = ma_z.$$

Third law

free body diagram



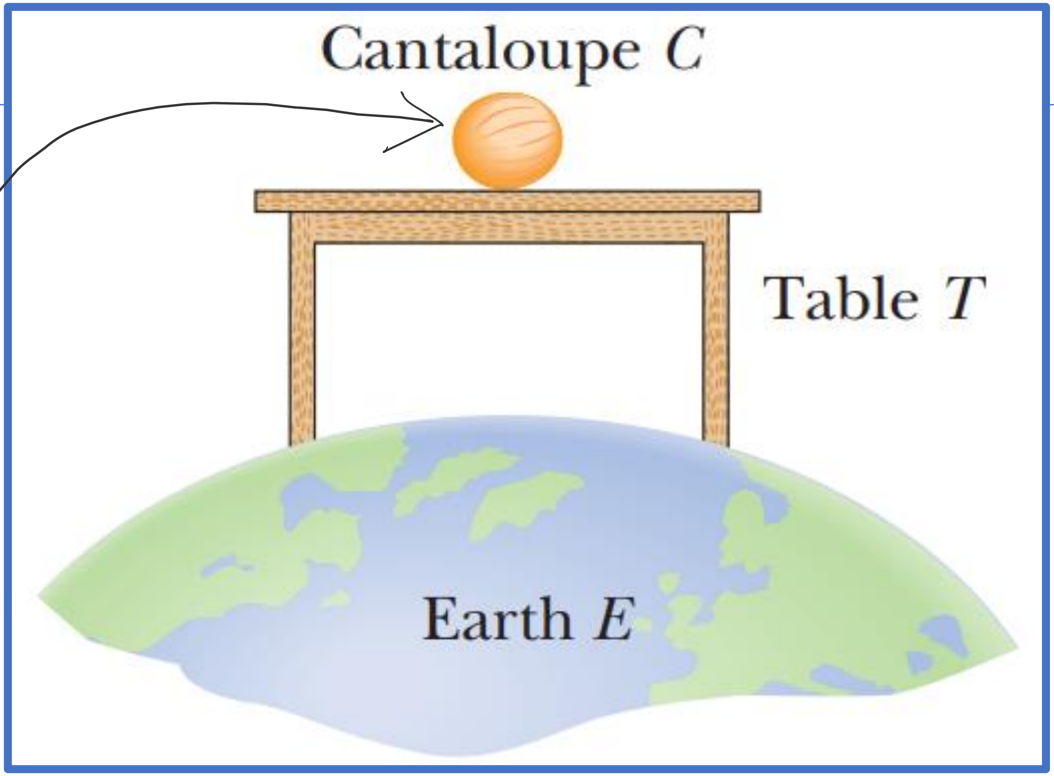
$$\vec{F}_{BC} = -\vec{F}_{CB}$$

in free body diagram you draw all the forces acting on the body

not the forces acted by the body

No. of objects = 3

System being solved for =

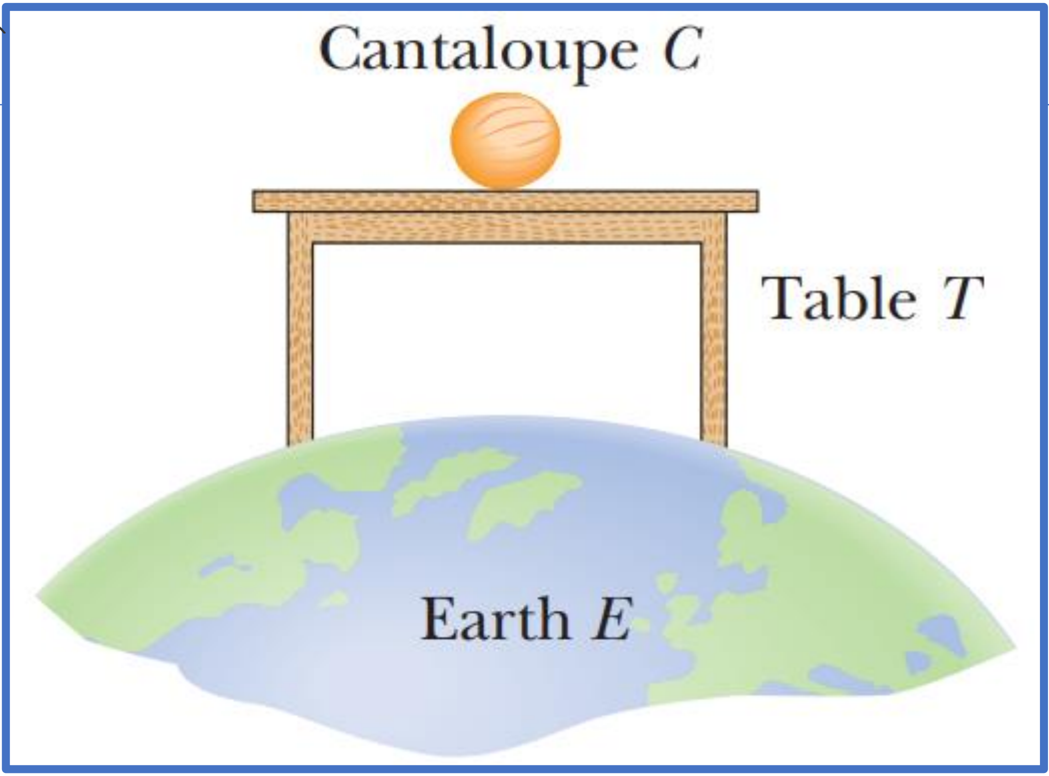


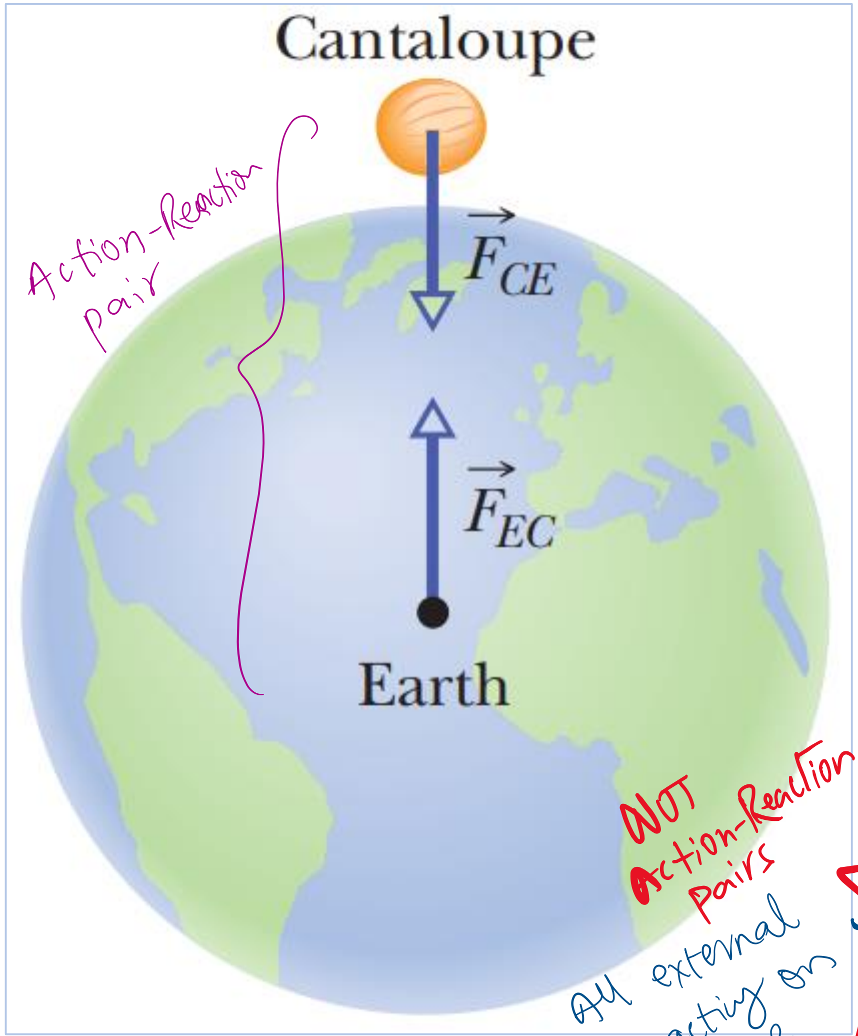
Technique

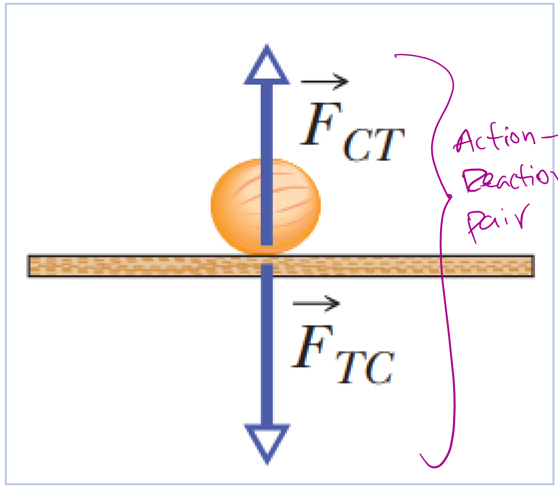
Solve by considering each interaction independently

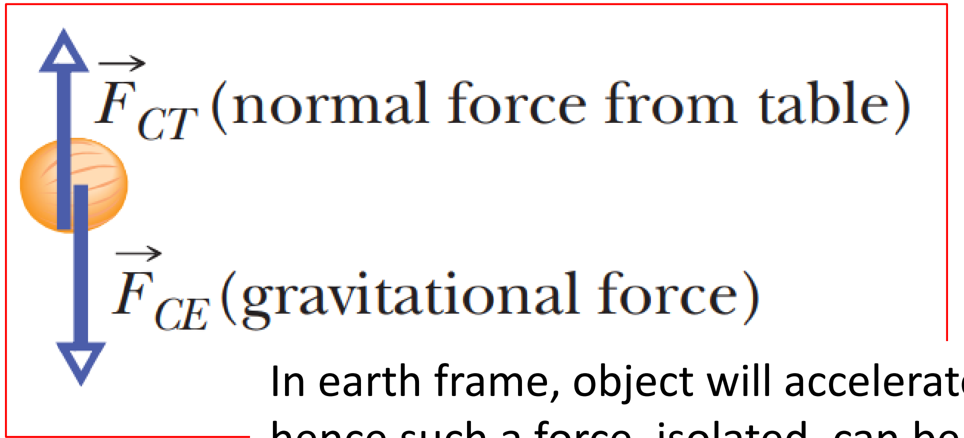
① Cantaloupe / Earth interaction

② Cantaloupe / table interaction









NOT Action-Reaction pairs

All external forces acting on Cantaloupe

Mathematical form for Cantaloupe motion

$$\boxed{F_N - F_g = ma_y.}$$

$a_y = 0$ cantaloupe at rest.

$a_y \neq 0$ cantaloupe moves (consider flexible surface like a rubber sheet or foam)

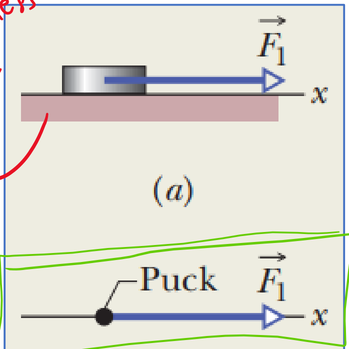
In earth frame, object will accelerate with acceleration 9.8m/s2 hence such a force, isolated, can be mathematically written as

$W = mg$ (without table or anything)

Lecture 7

Three different conditions on sliding puck

frictionless surface



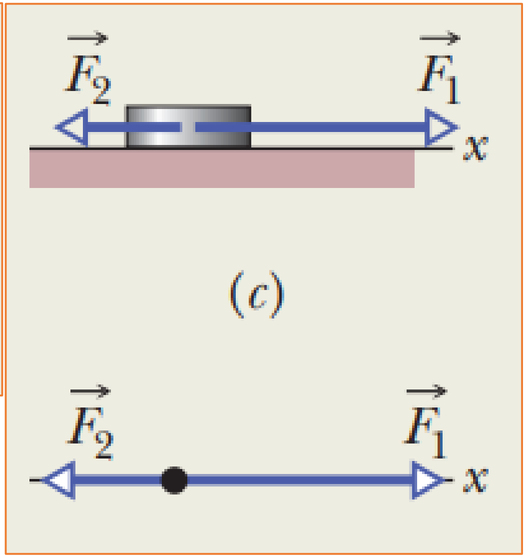
Free-body diagram

$$a_x = \frac{F_1}{m} = \frac{4.0\ \text{N}}{0.20\ \text{kg}} = 20\ \text{m/s}^2.$$

$$F_1 - F_2 = ma_x,$$

which, with given data, yields

$$a_x = \frac{F_1 - F_2}{m} = \frac{4.0\ \text{N} - 2.0\ \text{N}}{0.20\ \text{kg}} = 10\ \text{m/s}^2.$$



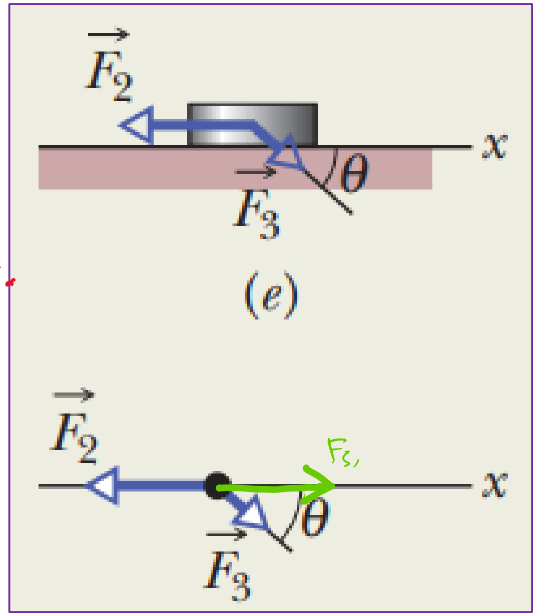
$$F_{3,x} - F_2 = ma_x. \tag{5-5}$$

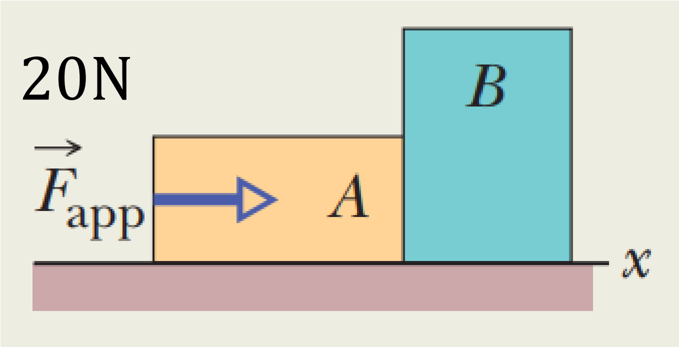
From the figure, we see that $F_{3,x} = F_3 \cos\theta$. Solving for the acceleration and substituting for $F_{3,x}$ yield

H.W Solve vertical forces for this part.

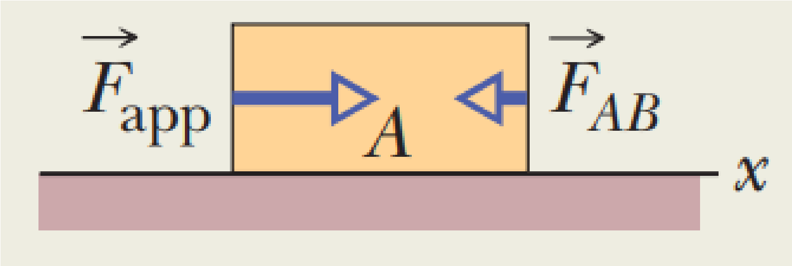
$$a_x = \frac{F_{3,x} - F_2}{m} = \frac{F_3 \cos\theta - F_2}{m}$$

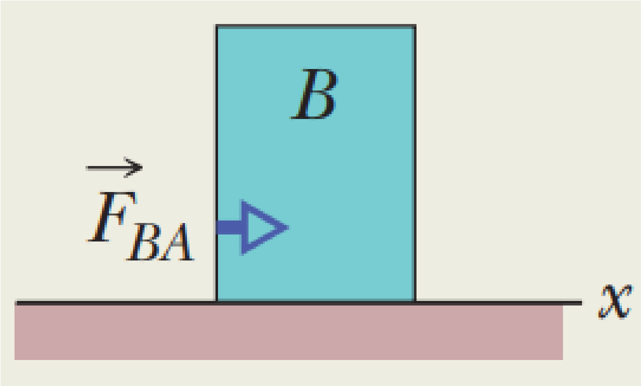
$$= \frac{(1.0\ \text{N})(\cos 30°) - 2.0\ \text{N}}{0.20\ \text{kg}} = -5.7\ \text{m/s}^2.$$





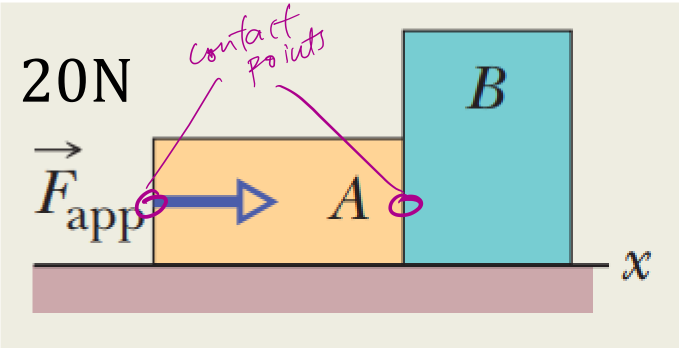
$m_A = 4.0$ kg,
$m_B = 6.0$ kg.





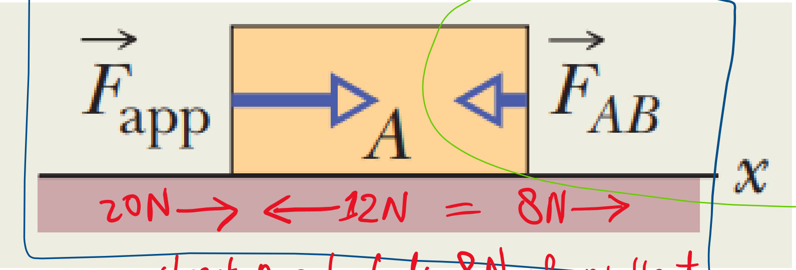
$-F_{AB} = F_{BA}$

Hidden forces at the AB contact



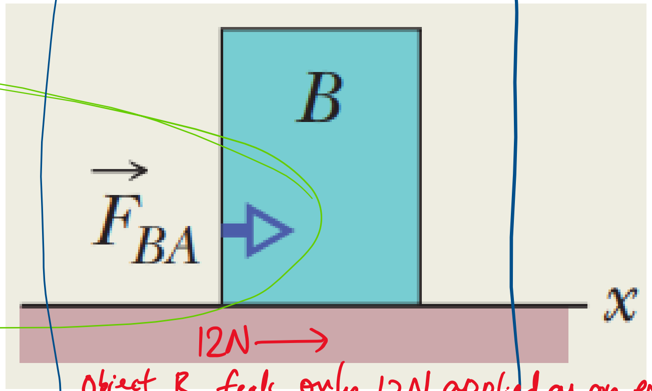
Total forces on A

Action-reaction pair



object A only feels 8N of resultant force applied on it.

Total forces on B



object B feels only 12N applied as an external force rather than 20N.

$m_A = 4.0$ kg,
$m_B = 6.0$ kg.

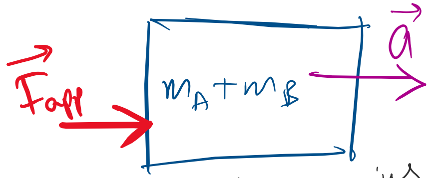
Solving for combined system of A and B

$$F_{app} = (m_A + m_B)a,$$

$$a = \frac{F_{app}}{m_A + m_B} = \frac{20\text{ N}}{4.0\text{ kg} + 6.0\text{ kg}} = 2.0\text{ m/s}^2.$$

Also consider this, if we reduce m_A w.r.t m_B then $\boxed{F_{BA} \approx F_{app}}$

therefore massless object transfer forces unaltered from end to end. Strings/Ropes are considered to be massless for the same reason.



This acceleration remains the same for A and B only because both are rigid objects

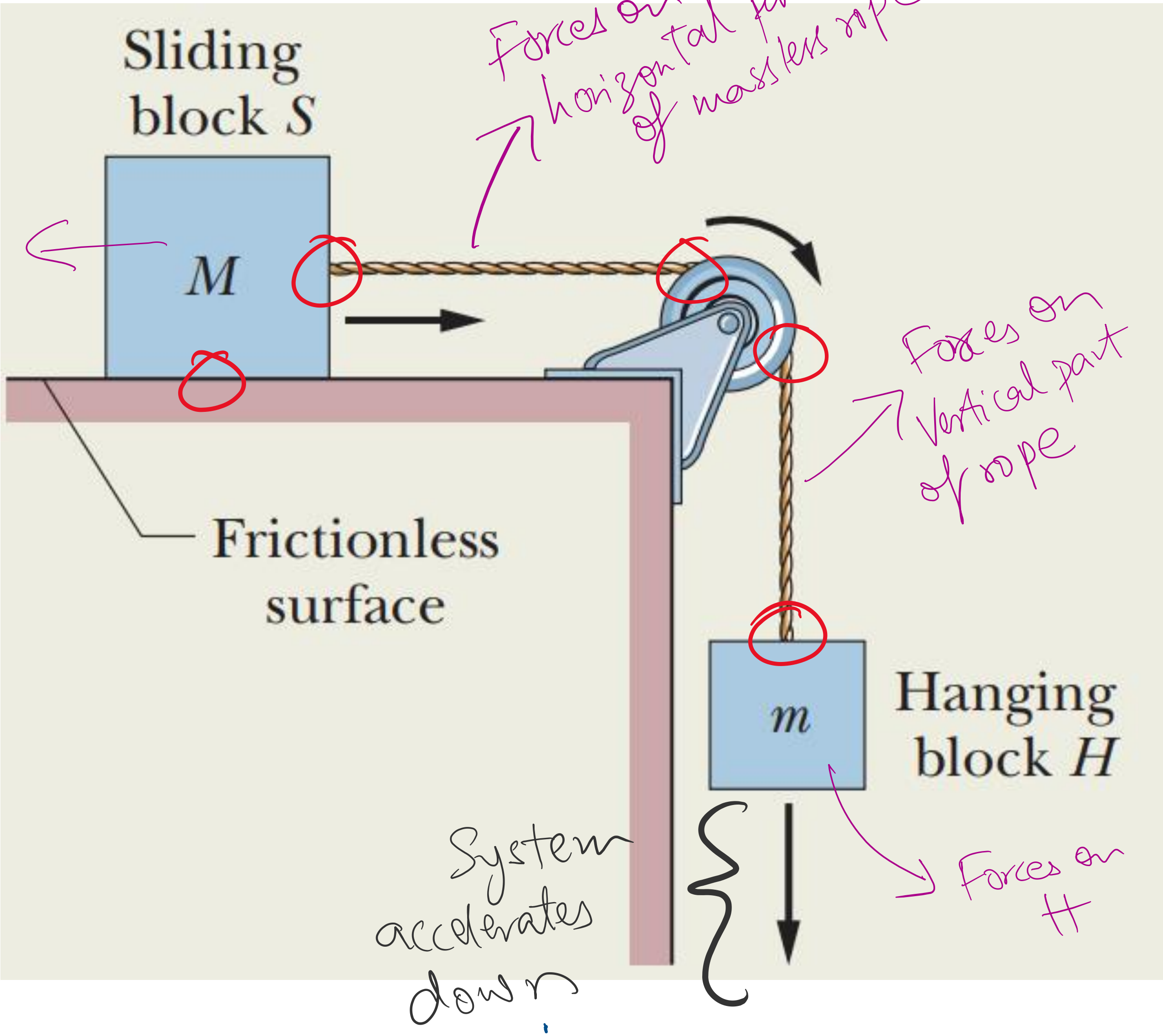
$F_{AB} = m_A a$
$= (4\text{ kg})(2\text{ m/s}^2)$
$\boxed{F_{AB} = 8\text{ N}}$

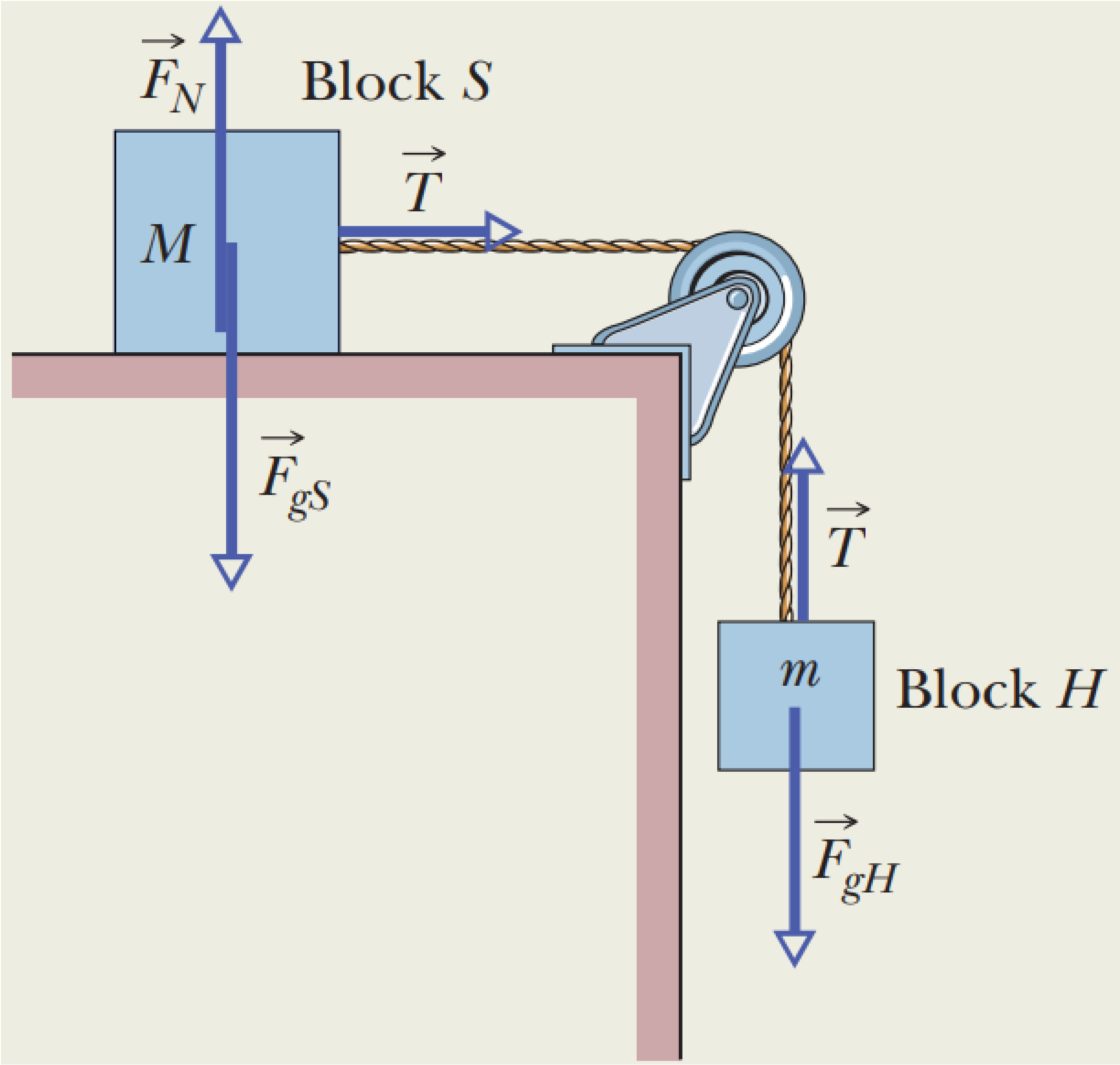
System of object B ⟶ $F_{BA} = m_B a,$

which, with known values, gives

$$F_{BA} = (6.0\text{ kg})(2.0\text{ m/s}^2) = 12\text{ N}.$$

Do not forget to point out all the contact points.





$\vec{F}_N$
Block S
$\vec{T}$
M
$\vec{F}_{gS}$
$\vec{T}$
m
Block H
$\vec{F}_{gH}$

Free-body diagrams

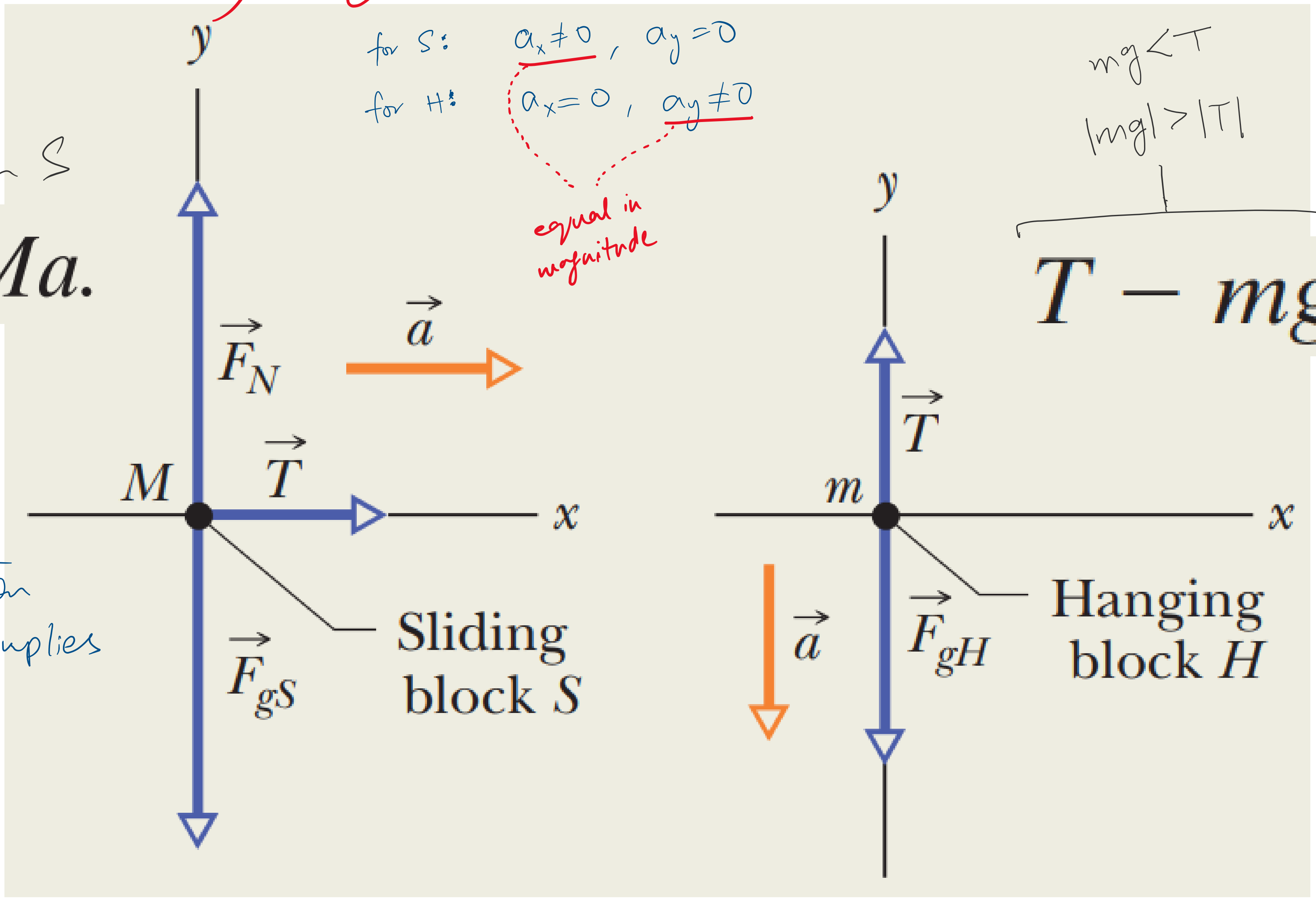
for S: $\underline{a_x \neq 0}$, $a_y = 0$

for H: $a_x = 0$, $\underline{a_y \neq 0}$

equal in magnitude

only force on S

$$T = Ma.$$



mg < T

|mg| > |T|

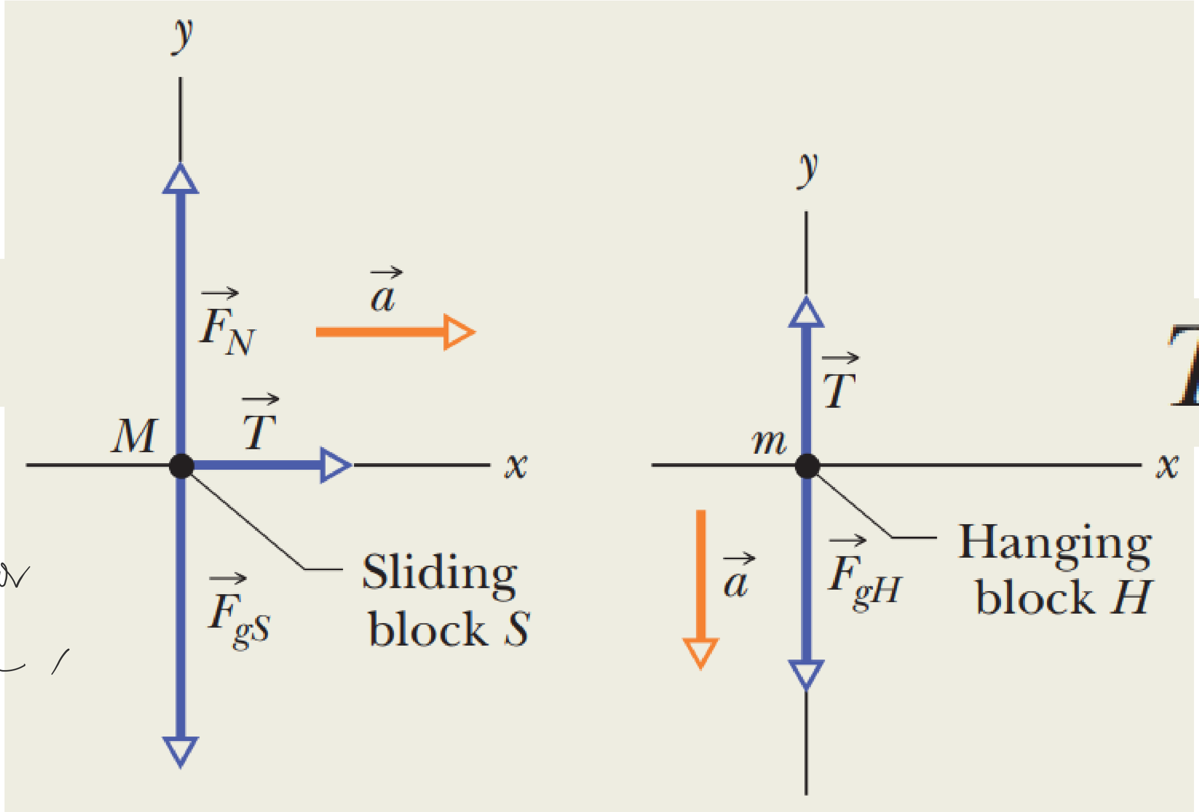
$$\underbrace{T - mg}_{} = \underbrace{-ma.}_{0 \neq}$$

No vertical motion for Block S implies

$$\boxed{\vec{F}_{gs} = \vec{F}_N}$$

$\vec{F}_N - \vec{F}_{gs} = 0$

$$T = Ma.$$



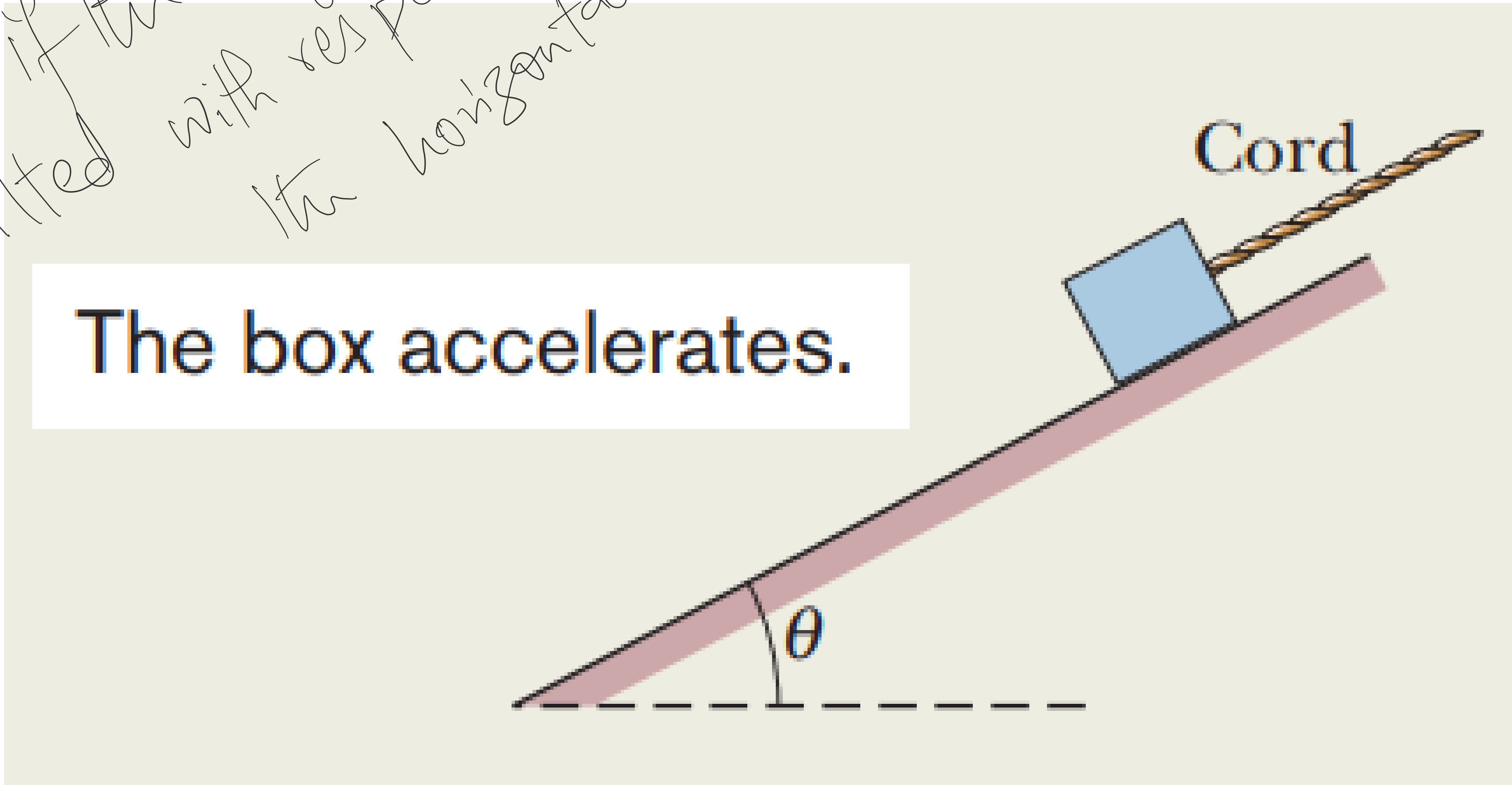
$$T - mg = -ma.$$

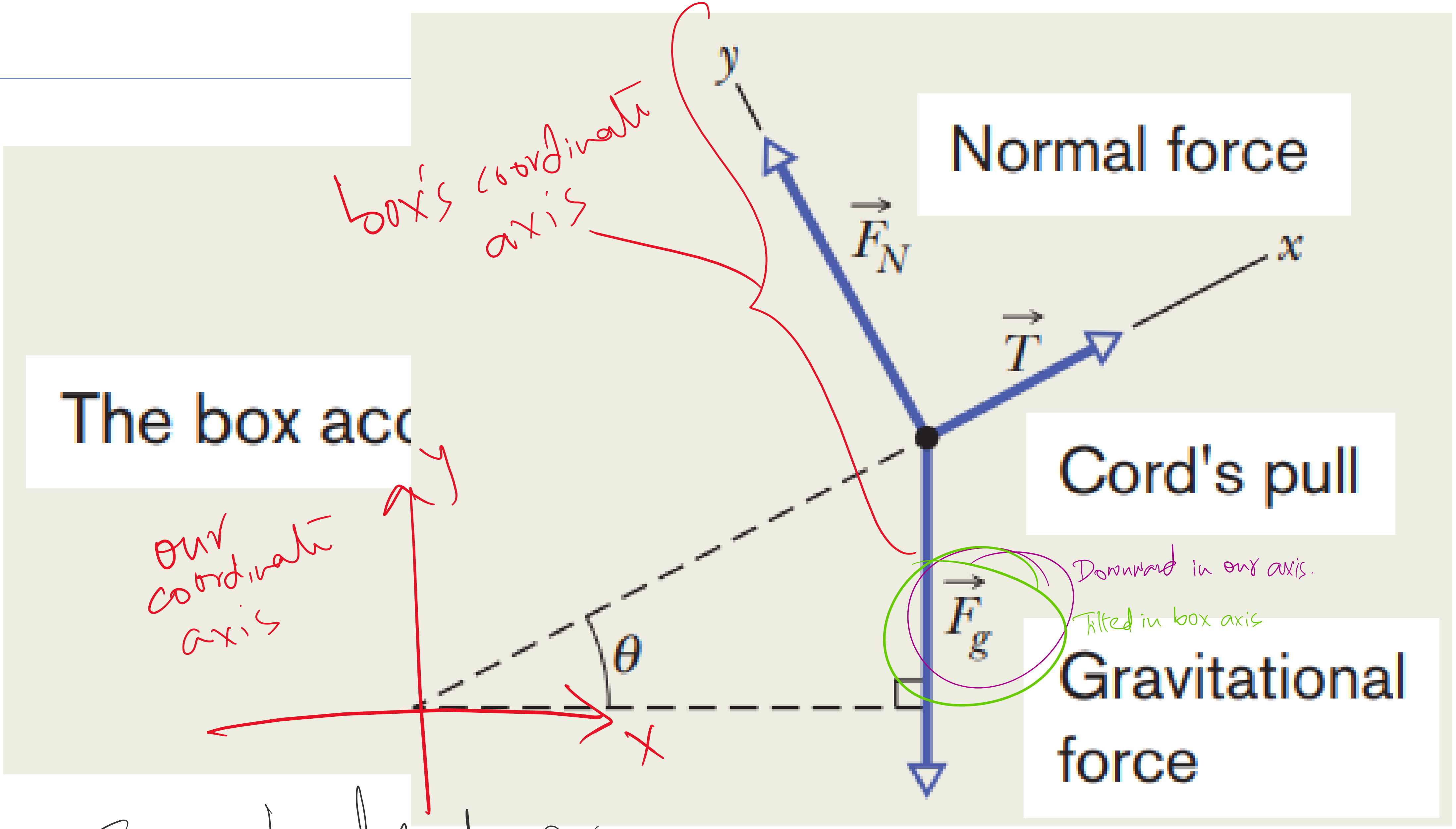
Simultaneously solving for the two unknowns here, $\vec{a}$ and $\vec{T}$

$$a = \frac{m}{M + m} g.$$

$$T = \frac{Mm}{M + m} g.$$

What if the surface
is tilted with respect to
the horizontal

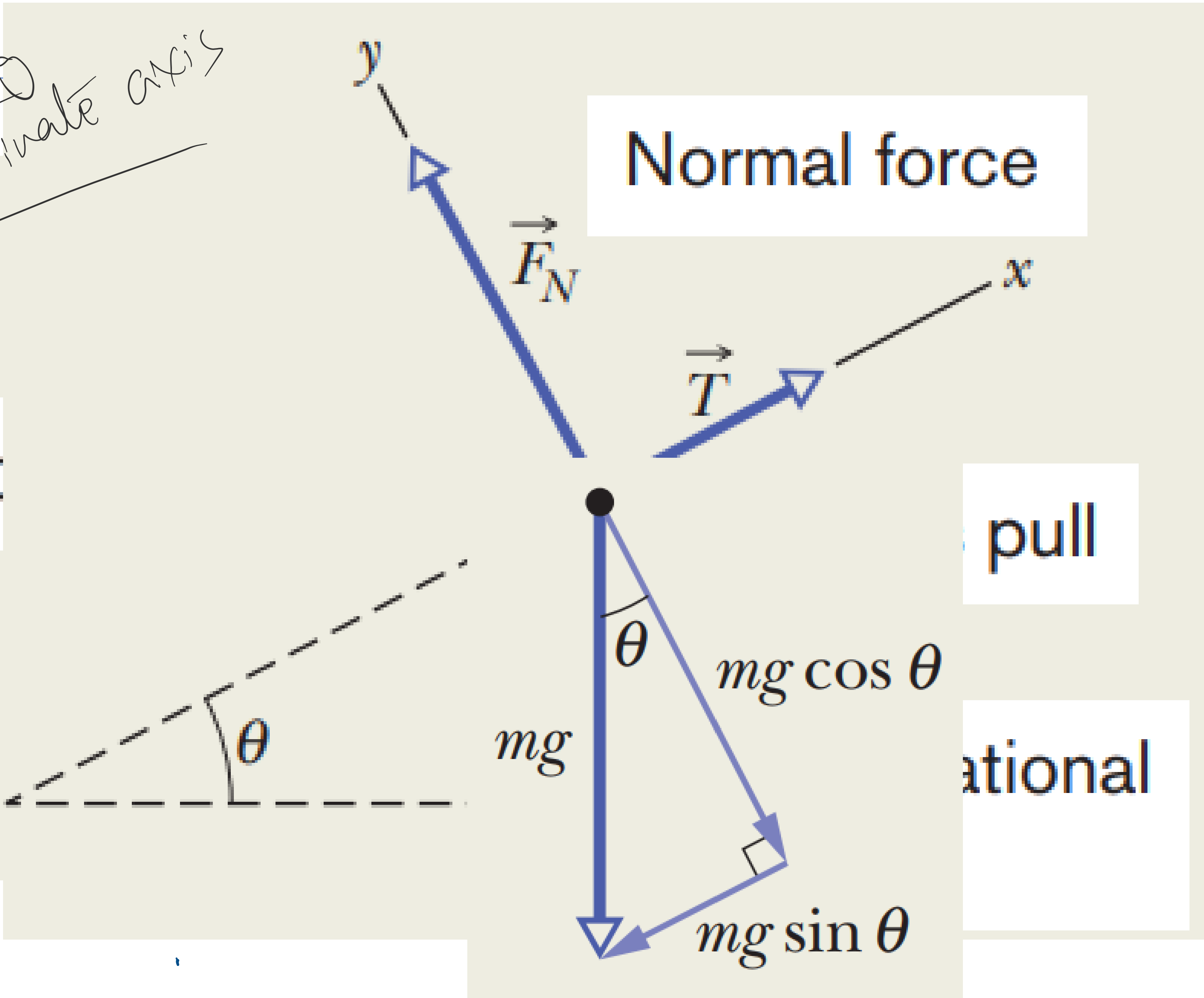


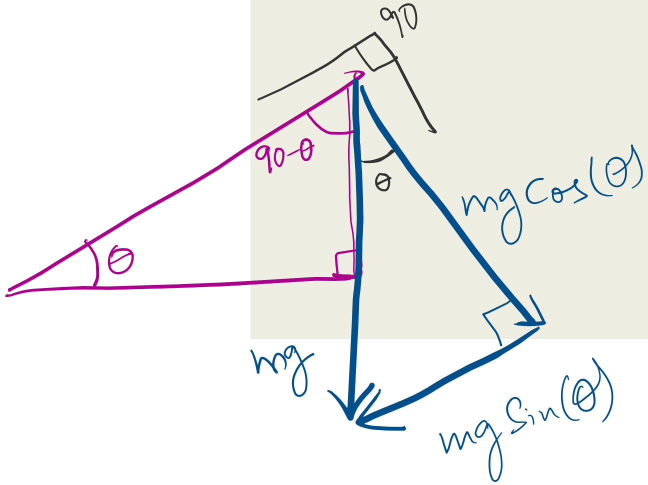


Free-body diagram

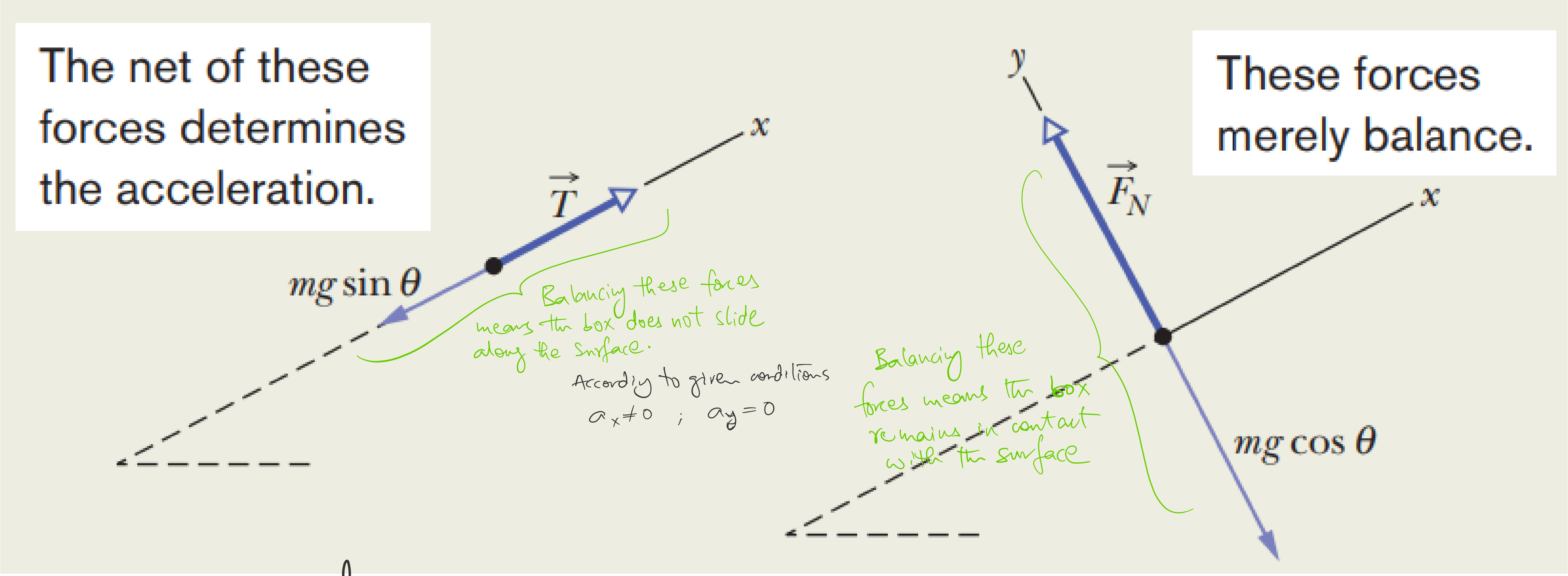
geometrical breakdown of $\vec{F}_g$ in the box's coordinate axis

The box acc





Lecture 7



Horizontal part

Vertical part

Practice problems:

Problems from **Fundamentals of Physics**

-Jearl Walker

Chapter 5 : Forces and Motion I

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Questions: 1,5,6,12,

Problems: 2,5,9,17,23,30,34,51,55,57

sample prob: 5.01,02,03

Additional Problems