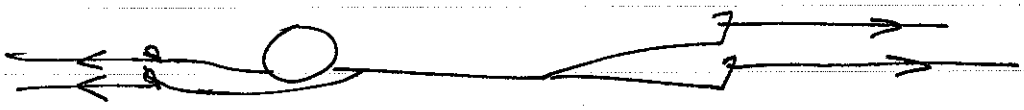
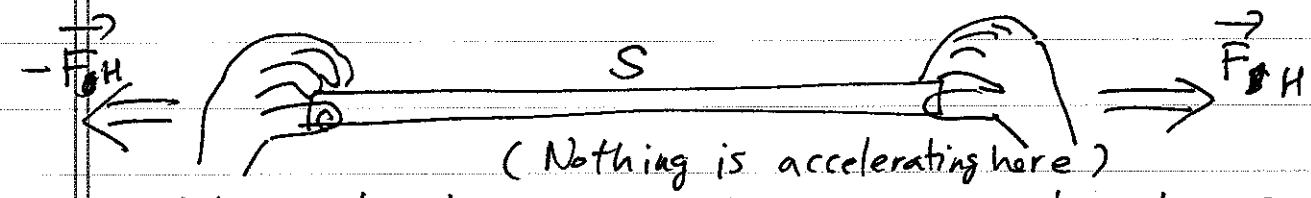
Tension and Spring force

(Restoring forces)



If your body is pulled like this what is your reaction ?!
To restore !

String, rope, spring act the same way.



Your hand is stretching the object S with force $\vec{F}_{SH}$, how does that object react ? It does this:

At contacts, the object S applies $\vec{F}_S$ and $-\vec{F}_S$

$\Rightarrow \vec{F}_S = -\vec{F}_H$ by Newton's 3rd law

The forces $\vec{F}_S$ and $-\vec{F}_S$ tend to restore the shape of S
resist the change of S
$\Rightarrow$ "restoring force" !

① String, rope ... : $\vec{F}_S$ is called $(-\vec{F}_S)$ "Tension"

② Spring ... : $\vec{F}_S$ $(-\vec{F}_S)$ is called Spring force

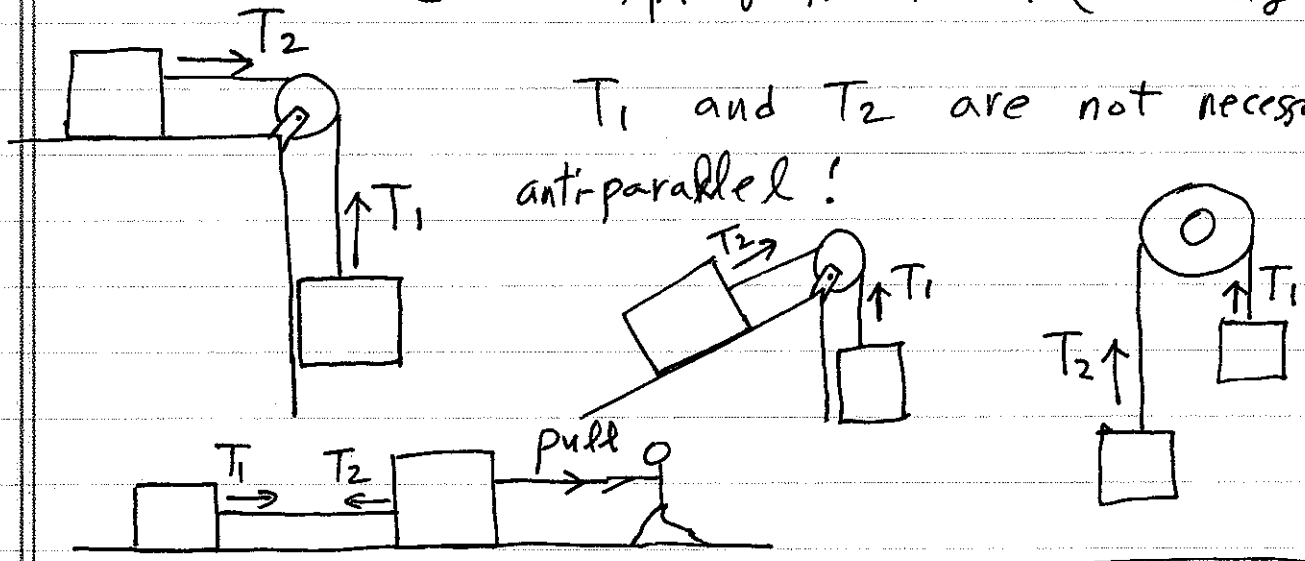
Both "delivers" force.

Differences : ① ... can be only stretched.

② ... can be stretched and compressed.

① .... string, rope can be in any curve (using pully)

② ... Sping is linear (normally)

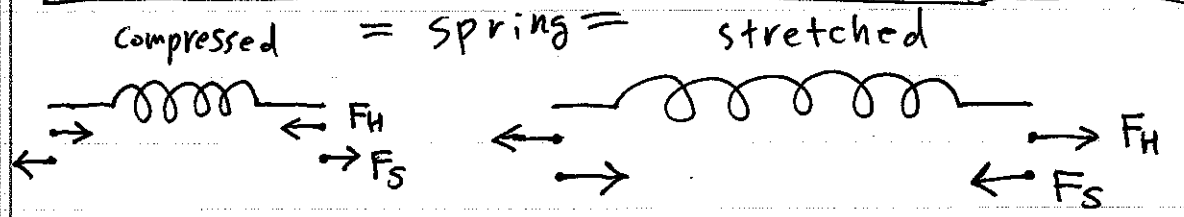


T_1 and T_2 are not necessarily anti-parallel!

** However, $T_1 = T_2$ (magnitude the same)

Always True if the string, rope is not accelerating.

True even when accelerating, if mass of (string / rope) is negligible.



Hooke's law

$F_S = -kx$ [the length of spring − the normal length of spring]

k: spring constant

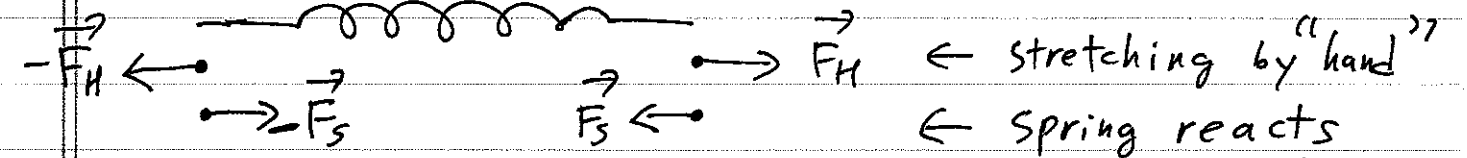
x: no compression, no stretching

$-$: means "restoring force", oppose the change x

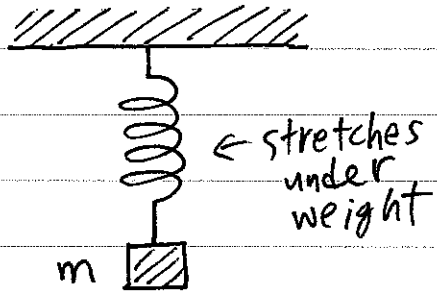
Important

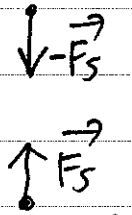
x here is not a position coordinate!

F_S is (opposite in direction, equal in magnitude) at the two ends of spring

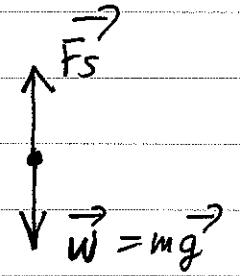


What is spring good for?
Measure force! weight!





Free body diagram of m



Note The same comment as ** in the previous page applies for the two spring forces at the two ends of a spring

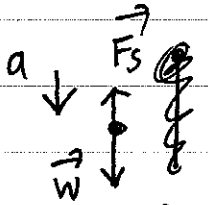
$kx = F_S = w$

measure $x \Rightarrow$ know w!

cf. Ex 4.5

Elevator revisited

True weight $\vec{w}$ never changes.
The apparent weight $\vec{F}_S$ changes!!



What if $a\downarrow$, $a \gtrless g$?