

PHY 117 HS2026

Balancing forces

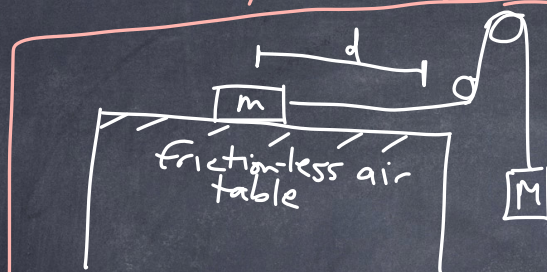
Week 2, Lecture 2
Sept. 23, 2026
Prof. Ben Kilminster
Prof. Florencia Canelli

Do the Week 2
Concepts quiz:
average completion time ~5min.

▼ Quiz 02

- ☐ Direction
- ☐ Average velocity
- ☐ Newton's laws I
- ☐ Newton's laws II
- ☐ Newton's laws III
- ☐ Newton's laws IV
- ☐ Equilibrium
- ☒ Forces

Extra: Yesterday, we had this problem:



What is acceleration of block m?

Neglect mass of string
Neglect friction of pulleys

There are 2 ways to solve this problem.

- 1) we look at the whole system
- 2) we look at each block



Consider that this is one object.
The total mass is $m+M$
It is accelerated by the force $F_g = Mg$

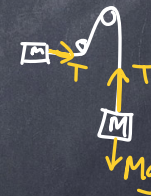
$$\text{So } \Sigma F = (\text{mass of system}) a$$

$$Mg = (M+m) a$$

$$a = \frac{M}{(M+m)} g$$

- 2) we look at the two blocks separately, and make equations for the forces on each.

block m:
There is only one force on m.
So $\Sigma F = ma$ ①
 $T = ma$



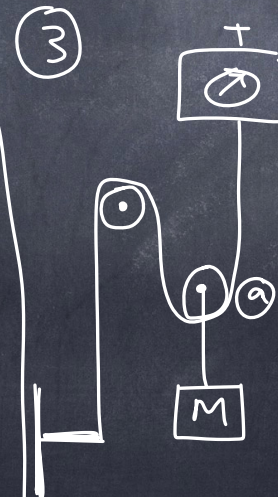
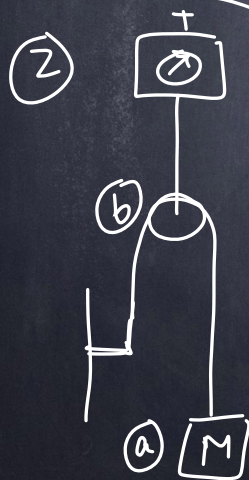
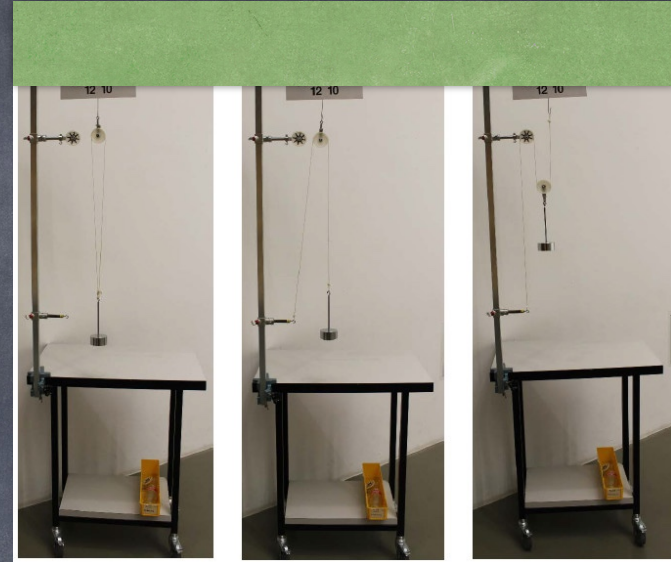
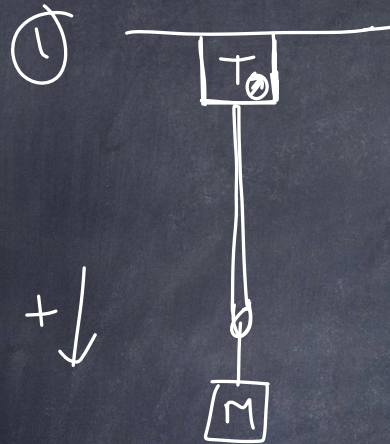
block M:
Here $\Sigma F = Ma$ ②
 $Mg - T = Ma$

Adding ① + ②, we get
so $a = \left(\frac{M}{M+m} \right) g$

$Mg - T + T = ma + Ma$
Notice that T cancels out.

Guess. that. Force!

Guess. That. force !
 options : 5N, 10N, 20N
 $M = 1 \text{ kg}$
 $M_g = 10 \text{ N}$

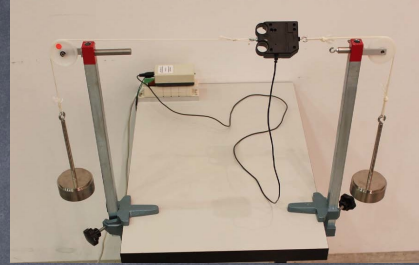


Guess. That. Force!

$$M = 2\text{kg}$$

$$Mg = 20\text{N}$$

options: 5N
10N
20N



$$M = 2\text{kg}$$

$$Mg = 20\text{N}$$

④



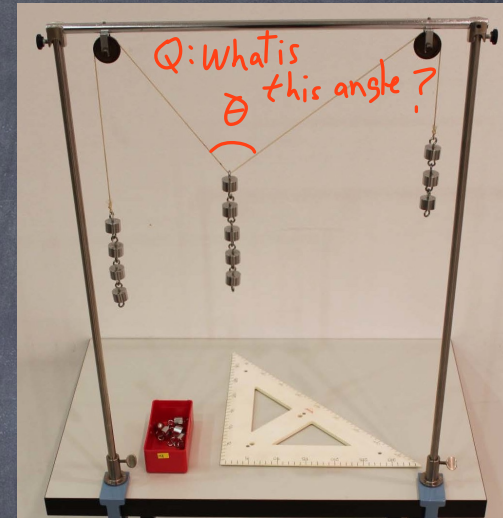
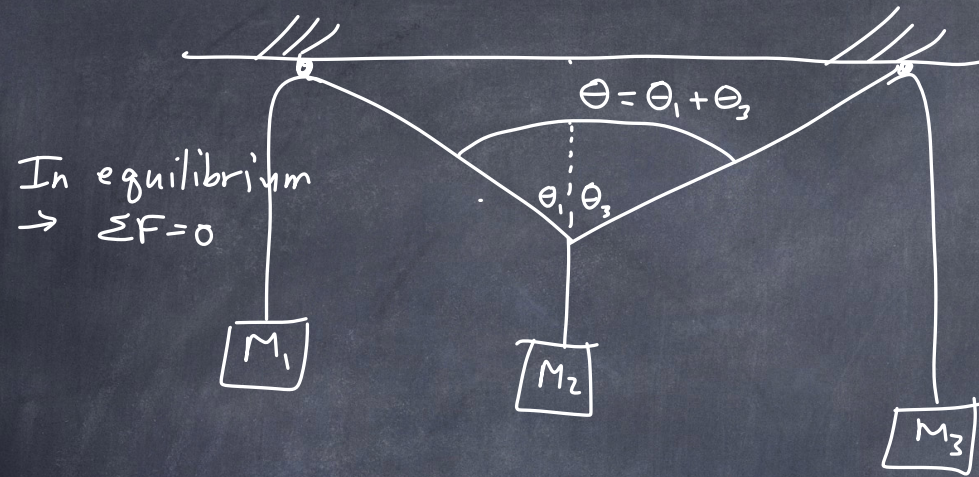
⑤

$$M = 2\text{kg}$$

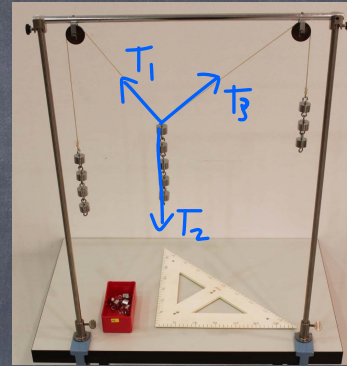
$$Mg = 20\text{N}$$



Static equilibrium: Guess that Angle!



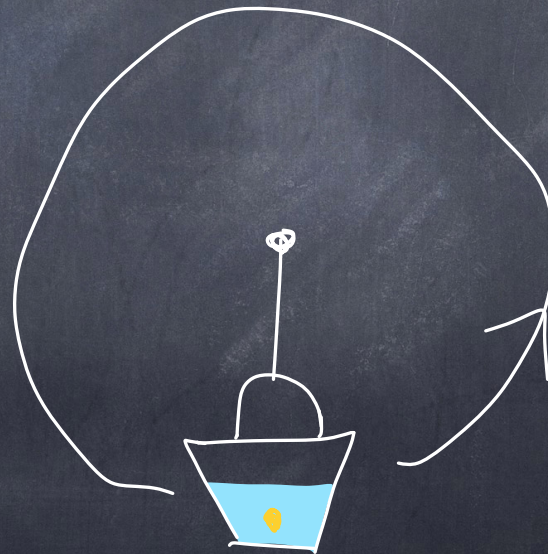
In our case, where $M_1 = 400\text{g}$, $M_2 = 500\text{g}$, $M_3 = 300\text{g}$,
so $T_1 = 4\text{N}$, $T_2 = 5\text{N}$, $T_3 = 3\text{N}$



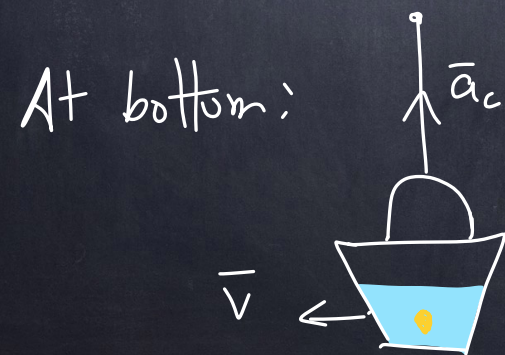
Let's now experimentally find the formula for the force on a spring.



Now:
Forces in circular
motion

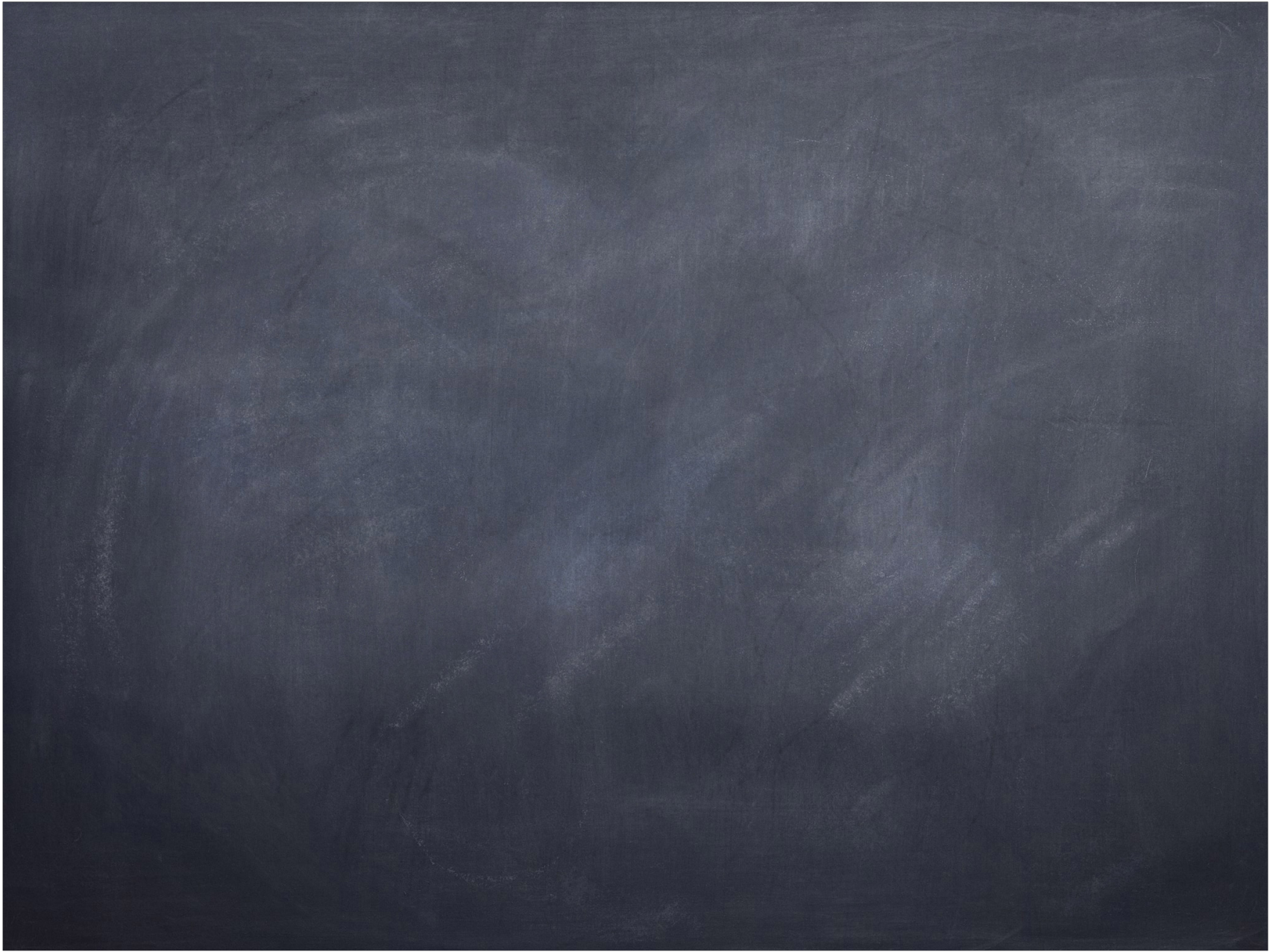


What are the forces on the water?



What is the minimum speed ($v_{\min}$) necessary to keep the water in the bucket?





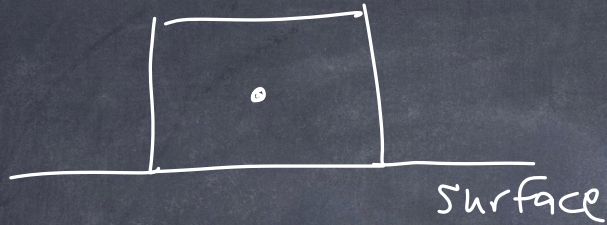
Now:

"Normal forces"

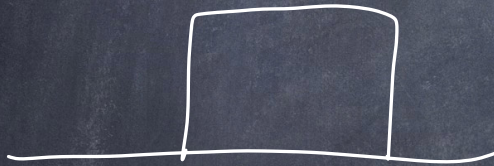
and

friction

block



we push or pull the block:



2 materials	μ_k	μ_s
wood on wood	0.2	0.25-0.5
teflon on steel	0.04	0.04
ice on ice	0.03	0.1
steel on steel	0.57	0.74
synovial joint	0.003	0.01



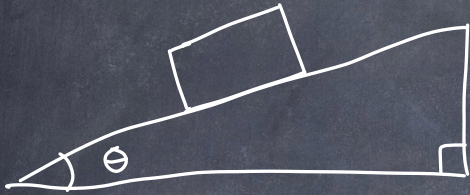


Measure Friction force with a spring

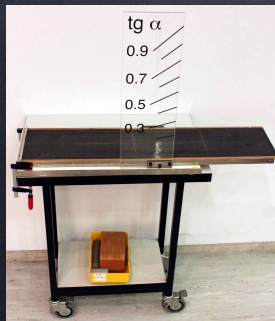
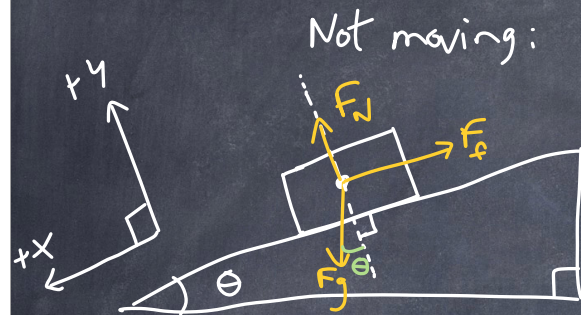


Consider block, mass M , on an incline, in equilibrium:

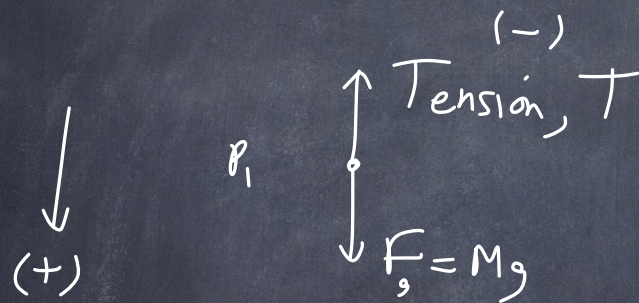
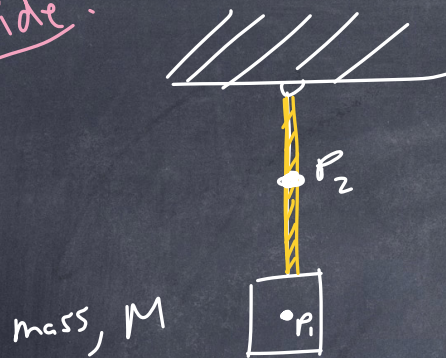
Not moving:



At equilibrium, forces balance:



Aside:



If we use vectors for $\vec{F}_g$ and $\vec{T}$, then we don't need to explicitly put negative signs in our sum, $\Sigma \vec{F}$.

$$\Sigma \vec{F} = \vec{F}_g + \vec{T} = 0$$

then $\vec{T} = -\vec{F}_g$

Since $\vec{F}_g = M\vec{g}$,
then $\vec{T} = -M\vec{g}$

Exercise:

A mass M hangs from a string to the ceiling.

Draw the forces acting at P_1 .

If we use T and F_g as scalars, then we need to keep track of negative signs.

↓ We state T is in $(-)$ direction

$$\Sigma F = F_g - T = 0 = ma$$

$$\text{and } T = F_g$$

But we must specify the direction

$F_g = Mg$ in $(+)$ direction

$T = Mg$ in $(-)$ direction

← ↑ In both cases F_g points down
& T points up.

