

PHY 117 HS2026

Today:

Circular motion

Integral = area

Forces

Newton's 3 Laws

+ Survey results

Week 2, Lecture 1

Sept. 22, 2026

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Prof. Florencia Canelli

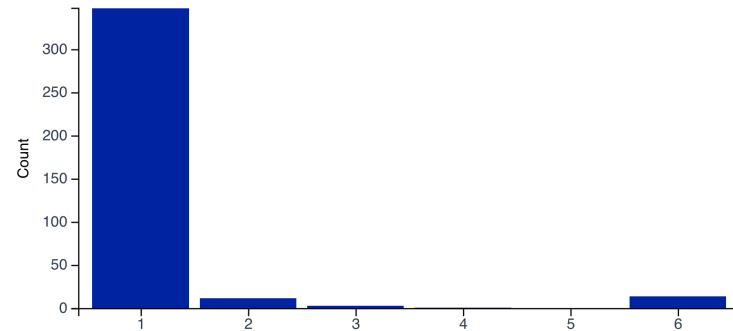
Survey results!

Who are you?

Number of participants

378

Where did you go to gymnasium / high school ?

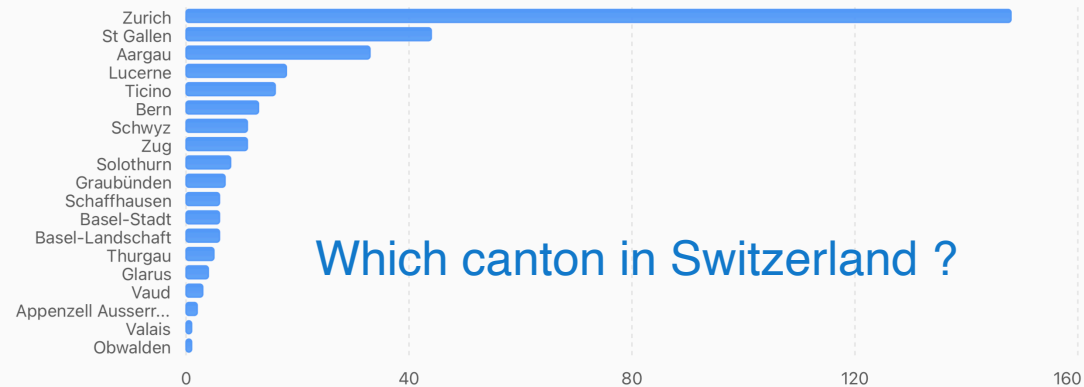


Legend

- 1: Switzerland
- 2: Germany
- 3: Austria
- 4: Italy
- 5: Liechtenstein
- 6: other

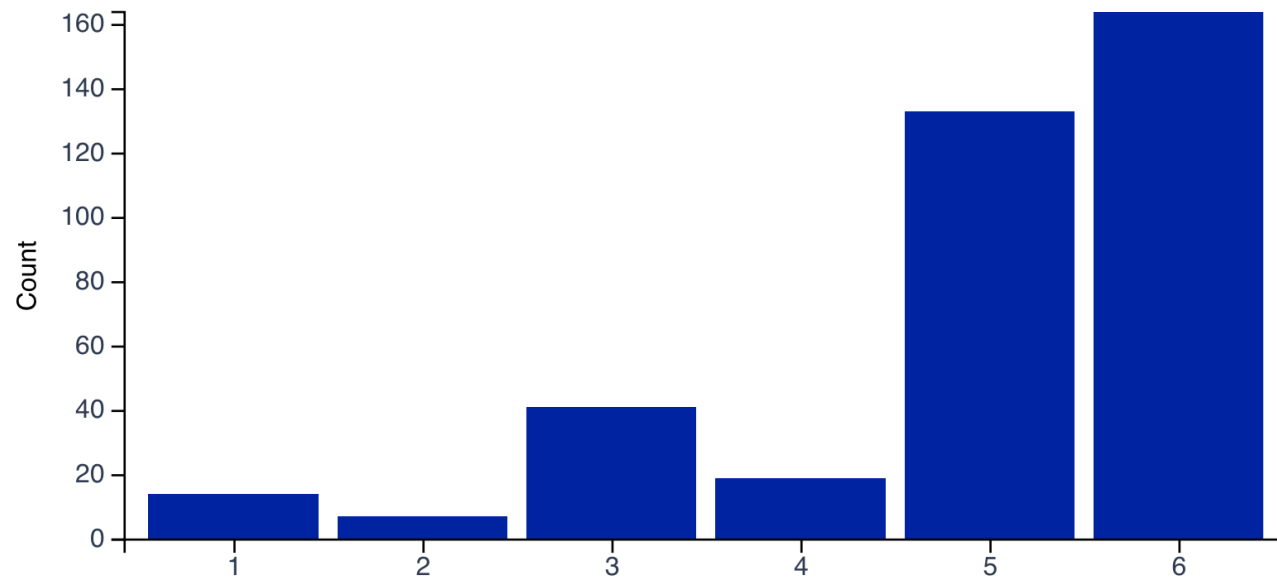
Other countries where students attended high school

- United Kingdom (3)
- Costa Rica (1)
- Georgia (1)
- France (1)
- Italy / Switzerland (1)
- Turkey (1)
- Thailand (1)
- Canada (1)
- Spain (1)
- Liechtenstein (1)
- Hungary (1)
- Egypt (1)



Which canton in Switzerland ?

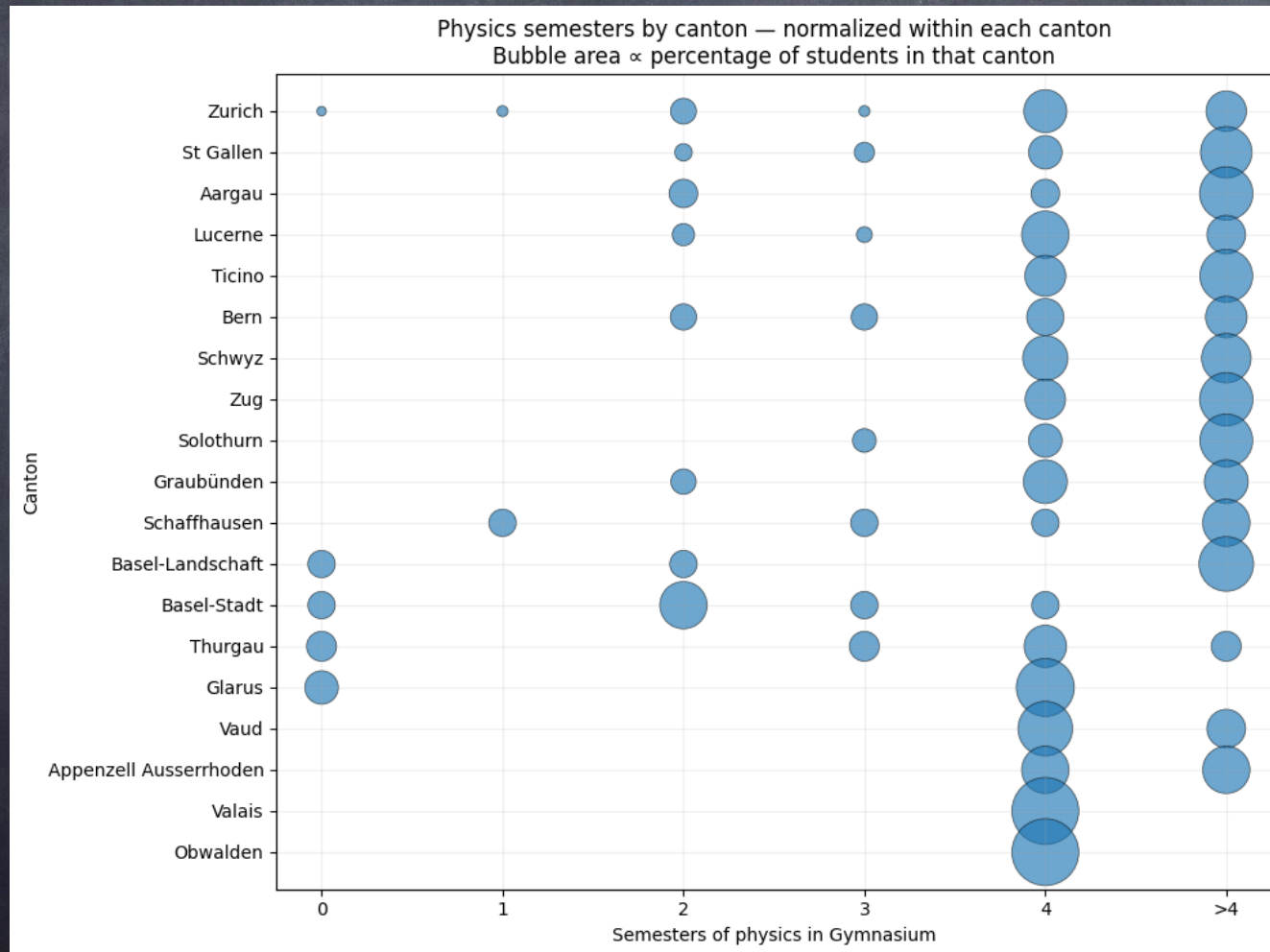
How many semesters of physics did you take in Gymnasium?



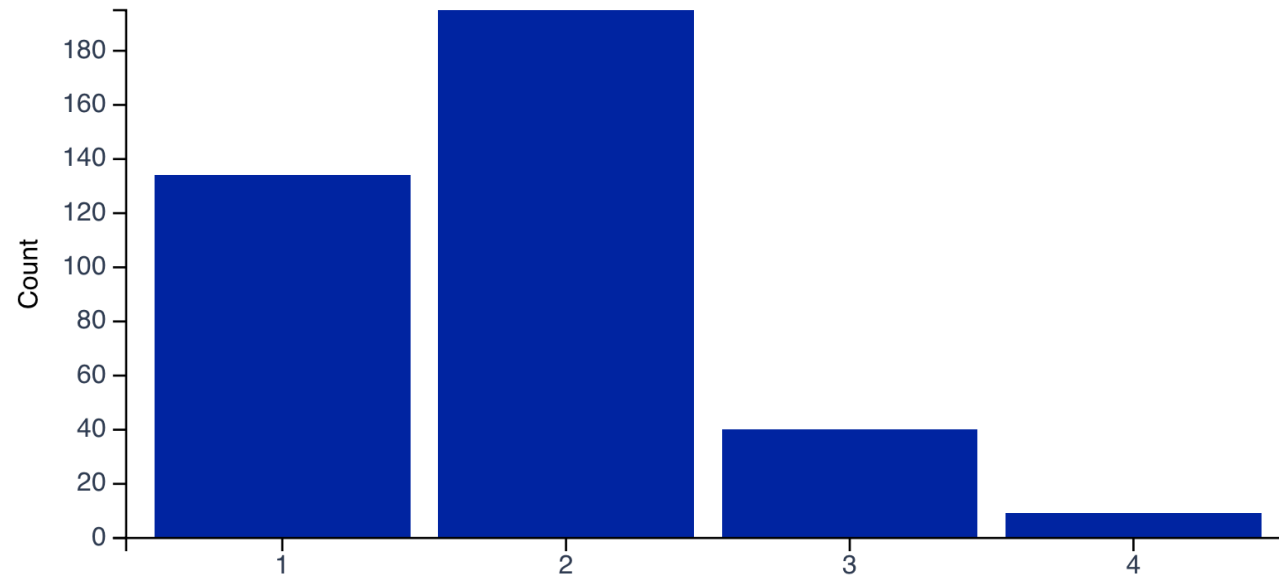
Legend

- 1:** non
- 2:** 1 semester
- 3:** 2 semester
- 4:** 3 semester
- 5:** 4 semester
- 6:** more than 4 semester

A little analysis ...



What is your major at UZH ?



Legend

- 1:** biology
- 2:** biomedicine
- 3:** biodiversity
- 4:** other

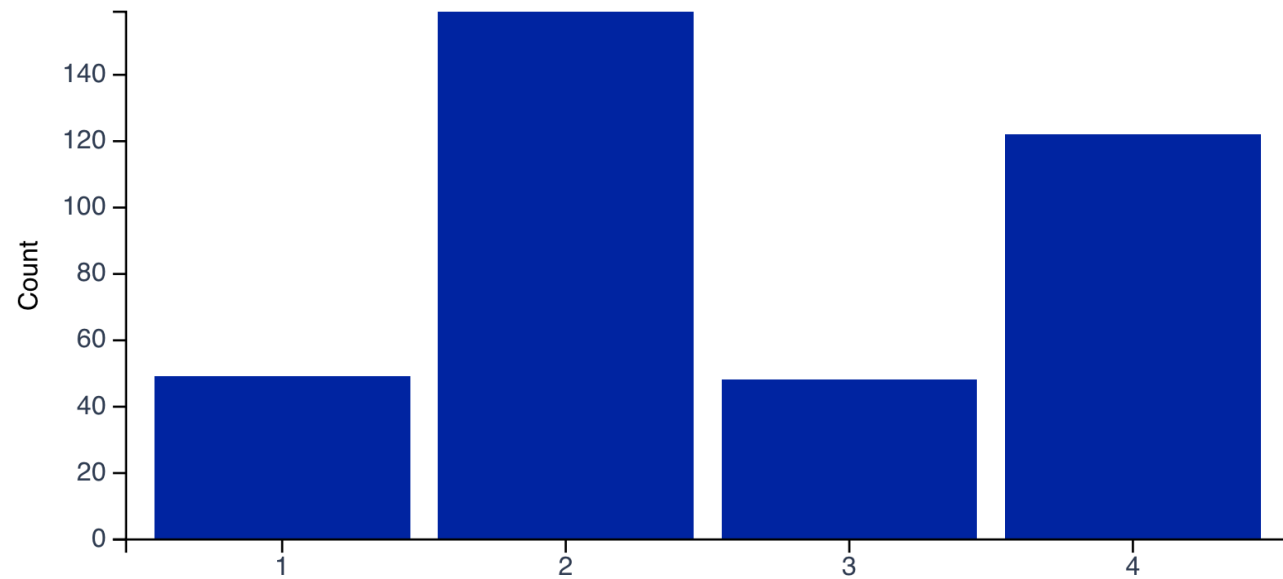
Other majors

- Psychology (3)
- Science Education / Teaching (1)
- Business Administration (1)
- Education Science (1)
- Archaeology (1)
- Political Science (1)
- Unspecified Master's student (1)
- No major specified (1)

Minors

- Astronomy & Astrobiology (13)
- Biomedicine (10)
- Business / Business Administration (10)
- Neuroinformatics (9)
- Biology (7)
- Bioinformatics (6)
- Earth System Sciences (6)
- Biodiversity (5)
- History, Politics & Society (5)
- Chemistry (4)
- Physics (4)
- Ethics (4)
- Sociology (3)
- Geography (3)
- Biochemistry (3)
- History (2)
- Law (2)
- Philosophy (2)
- German Language & Literature (2)
- Statistics / Probability (2)
- Communication & Media Studies (2)
- English / English Literature & Linguistics (2)
- Archaeology (2)
- French (2)
- Other individual minors (7)

Which statement fits you best ?



Legend

- 1:** I enjoy physics and I do quite well in it.
- 2:** I enjoy physics but I am not very good at it.
- 3:** I don't enjoy physics, but I do quite well in it.
- 4:** I don't enjoy physics, and I am not very good at it.

What students would particularly like to learn

- No specific topic / open to anything (13)
- Better general understanding of physics / build confidence or intuition (10)
- Applying formulas and solving physics problems correctly (5)
- Connections between physics and biology / biomedicine / other sciences (5)
- Electricity, circuits, electrical signalling & electromagnetism (4)
- Learning physics terminology / studying physics in English (4)
- "I just want to pass the class!" (3)
- Relativity (3)
- Learn the fundamentals / basics of physics (2)
- Astrophysics (2)
- MRI (2)
- Quantum physics / atomic & molecular physics (2)
- Hydrostatics / fluid dynamics (2)
- Experimental methods, uncertainties & measurement errors (1)
- Waves (1)
- Thermodynamics / diffusion / membrane physics (1)
- Radioactivity (1)
- Particle interactions (1)
- Physics applications to everyday life (1)
- Motivation, perseverance & discipline in learning physics (1)

"I'm a little
scared of it..."

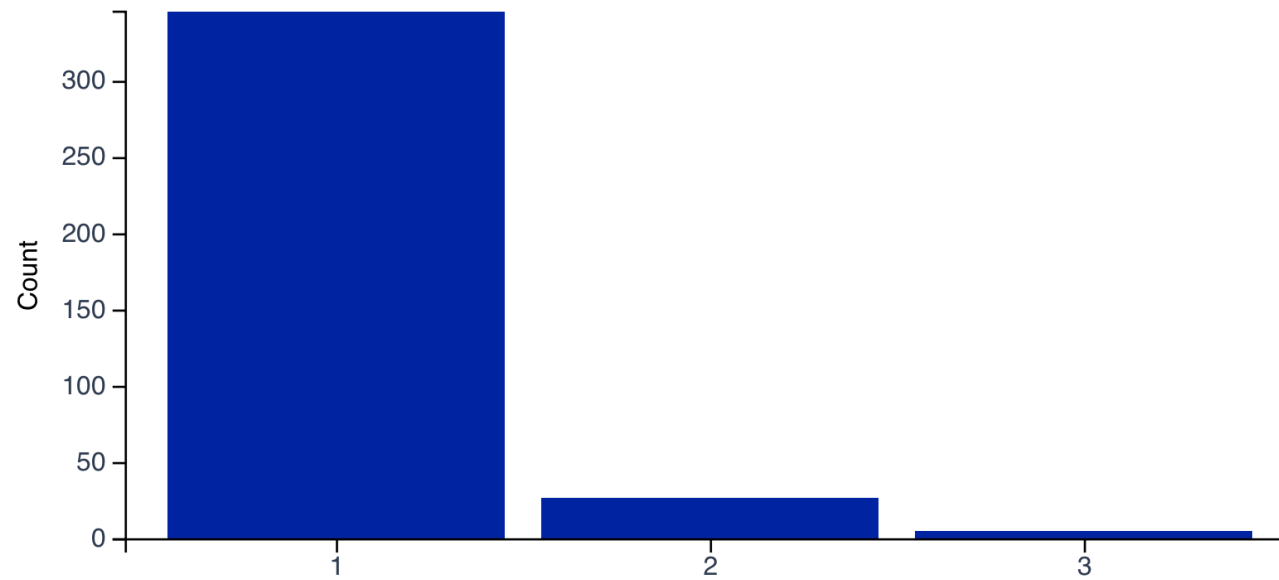
"I have no other choice..."

"I hope the lecturer
tries to make his
lectures
interesting"

"stuff useful
for general life"

"just want to pass bro"

Are you taking MAT 182 ?



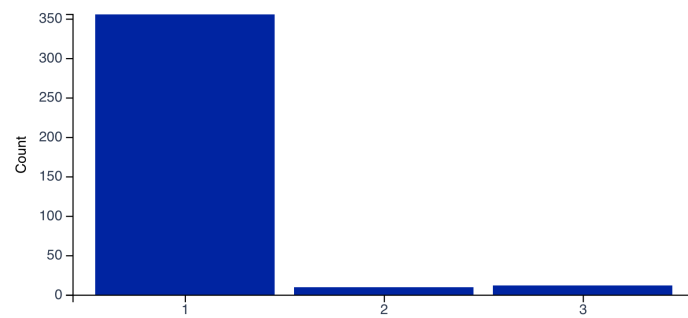
Legend

1: Yes

2: No

3: Not yet decided

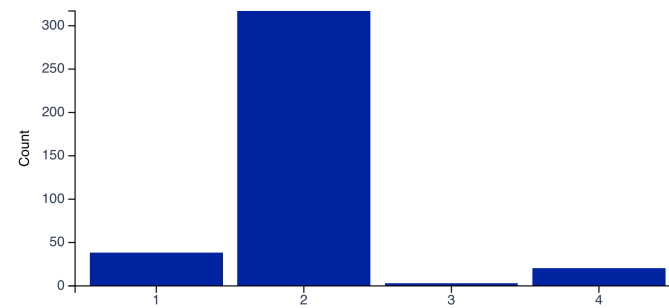
What is the derivative of x^3 with respect to x ?



Legend

- 1: $3x^2$
- 2: $2x^2$
- 3: $3x$

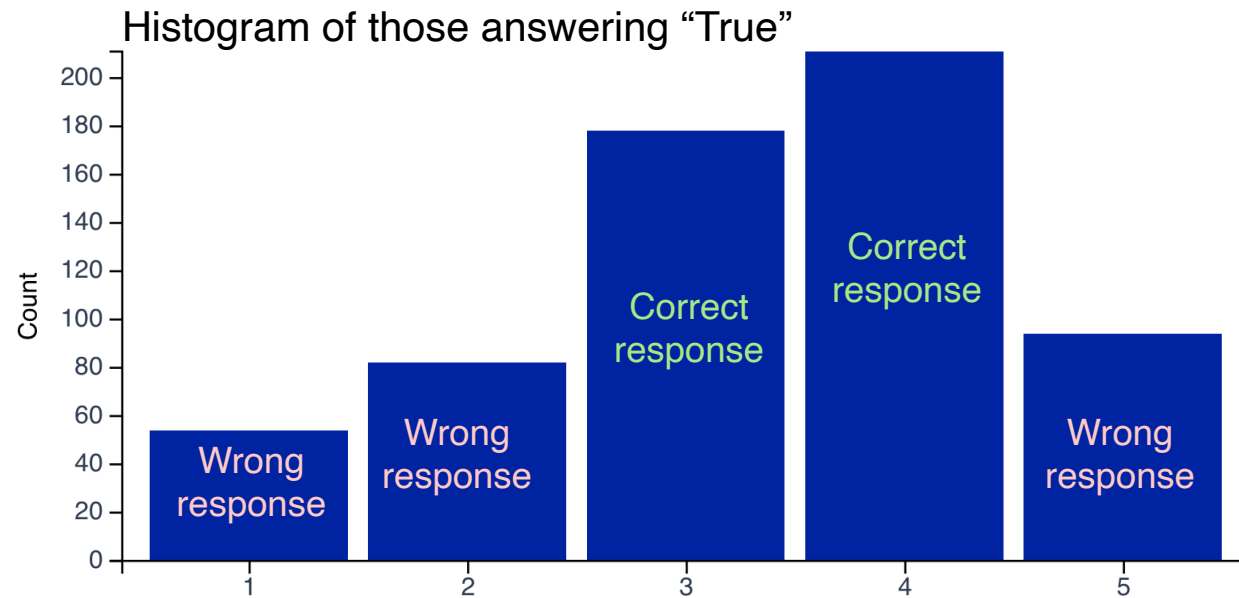
What is the integral of $3x^2$?



Legend

- 1: $6x$
- 2: x^3
- 3: 0
- 4: What's an integral?

Check all of the following statements that are true



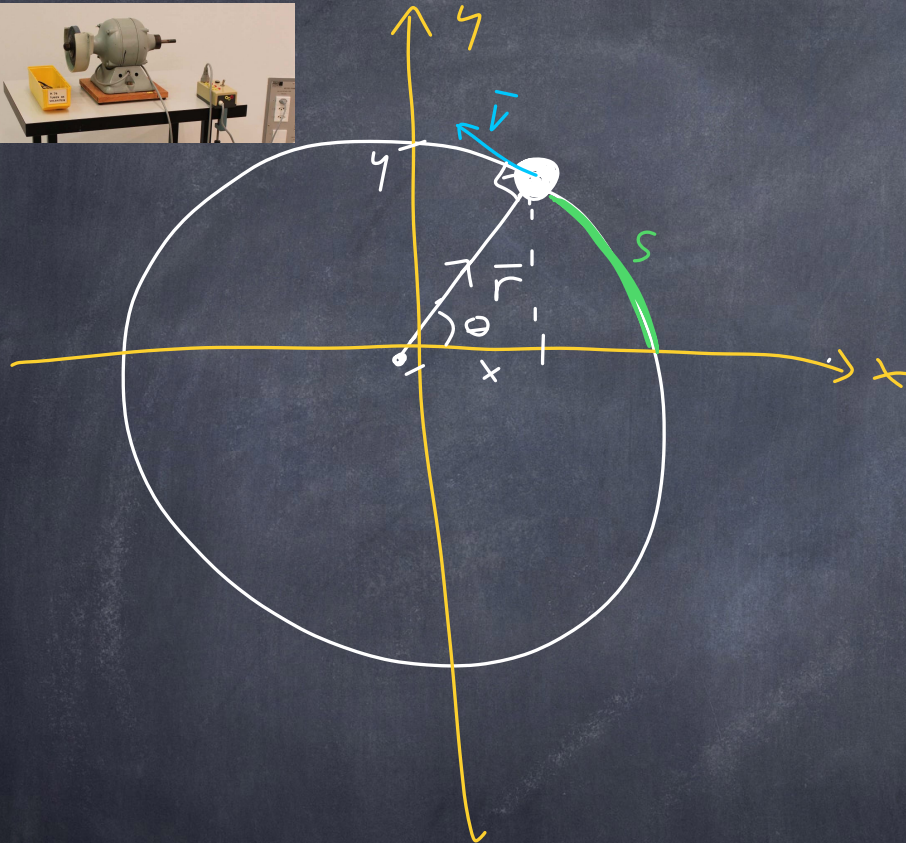
Legend

F
F
T
T
F

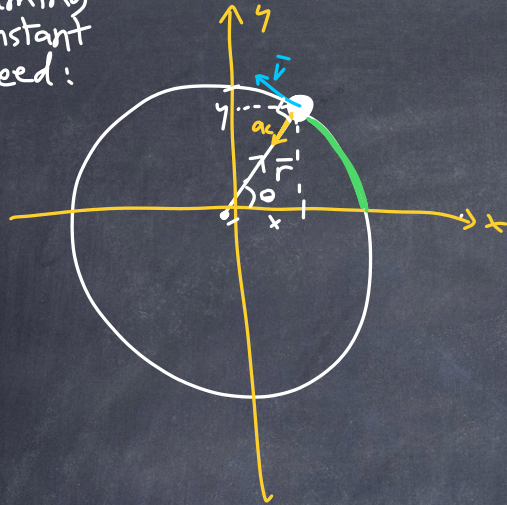
- 1:** A unit vector has a magnitude of zero.
- 2:** If a particle is moving at a constant velocity, the slope of distance vs. time will be zero.
- 3:** The position of a simple harmonic oscillator repeats in a time of $2\pi/\omega$.
- 4:** On the moon, a metal ball and a feather thrown from one astronaut to another would have the same parabolic motion.
- 5:** The acceleration of an object moving in a circle points in the same direction as the velocity.

And now back to our program...

Circular motion (in 2D)

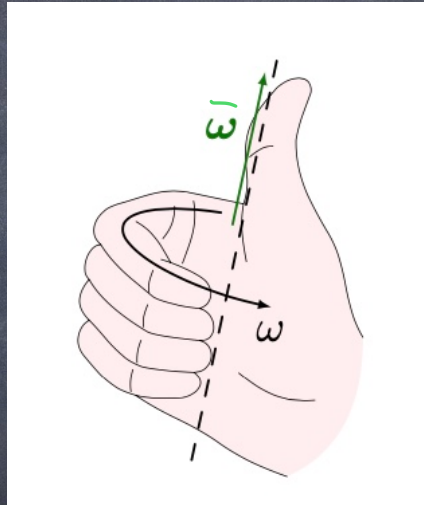


assuming
constant
speed:



Direction of $\omega + \bar{\omega}$ vector

right-hand rule

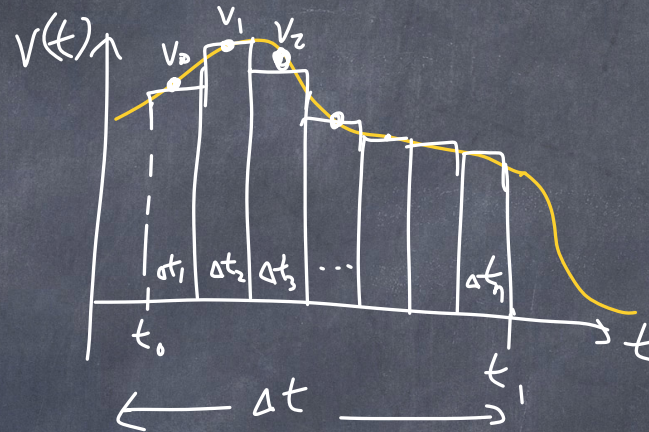
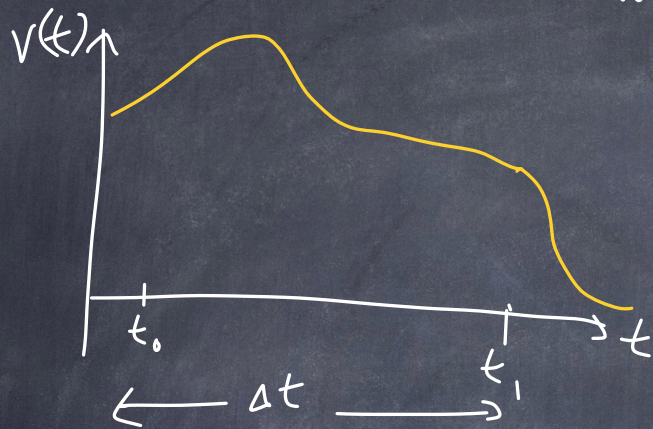


The concept of derivatives
is directly related to "slope"

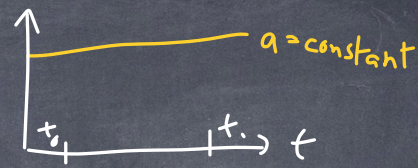
The concept of integrals
is directly related to "area"

Integrals $\leftrightarrow$ area

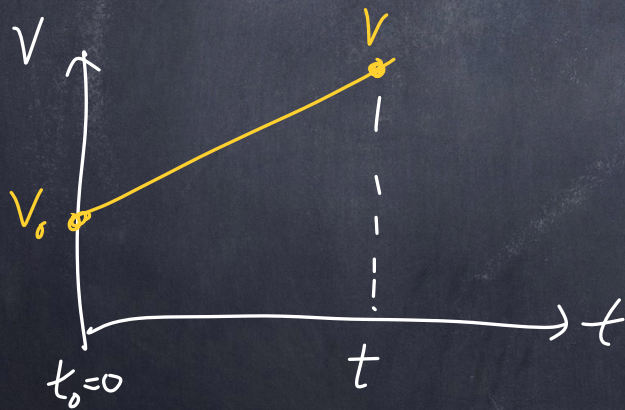
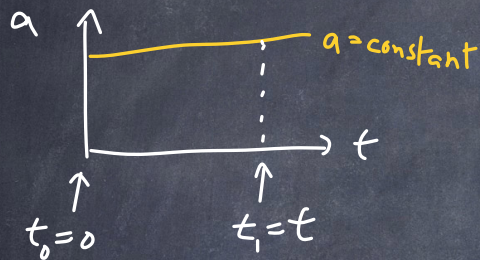
For a more complicated curve for v vs. t
we want to approximate Δx for this curve

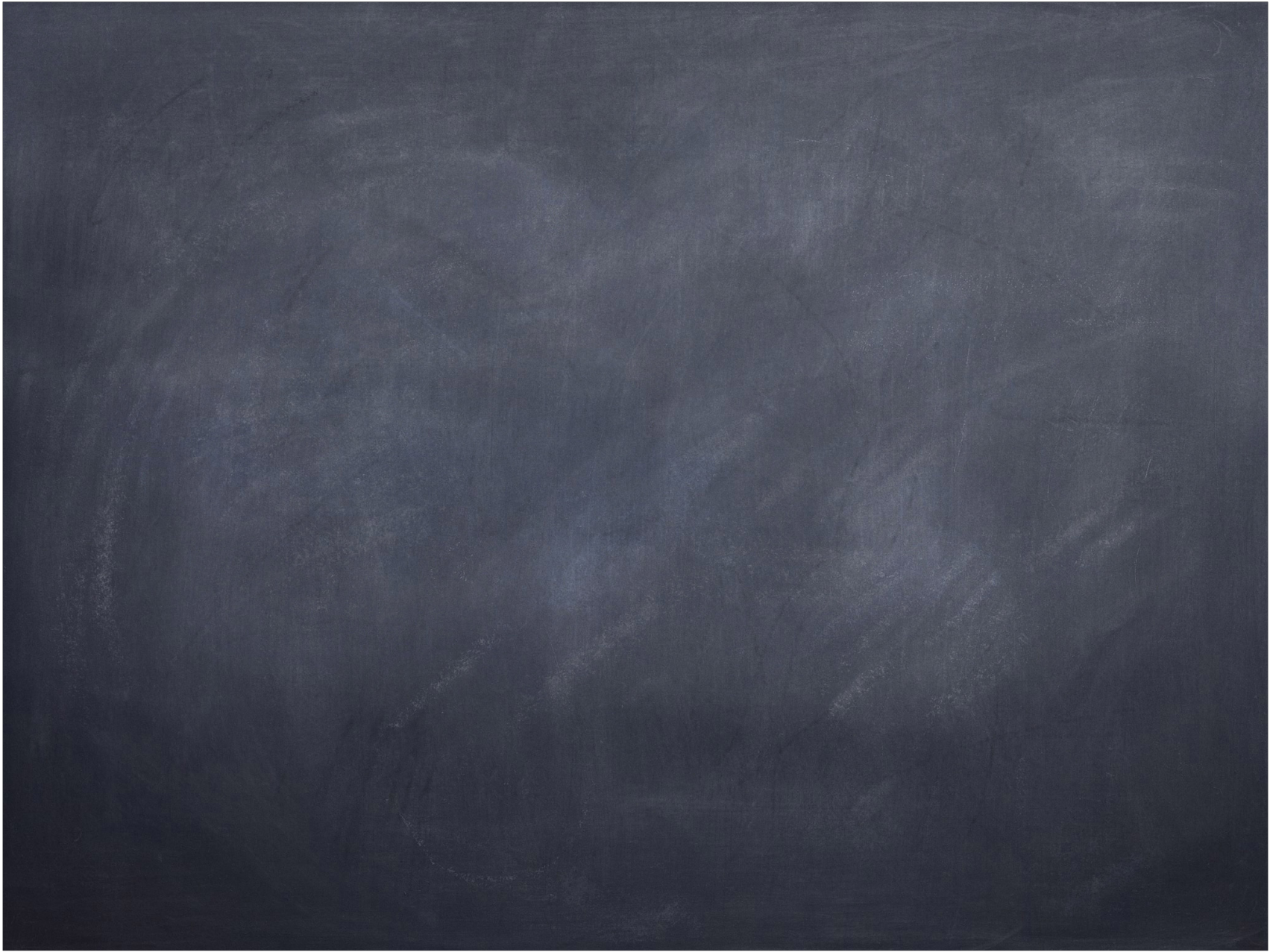


Likewise, $\Delta V = \lim_{\Delta t_i \rightarrow 0} \sum_i a_i \Delta t = \int_{t_0}^{t_1} a \, dt$



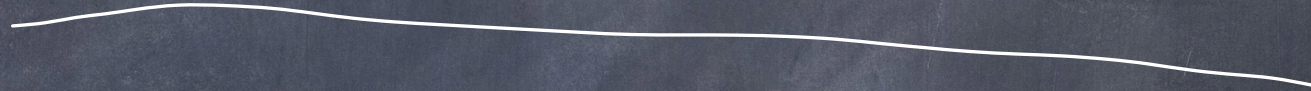
Assuming constant acceleration, what are formulas for $V = V(t)$ and $x = x(t)$?





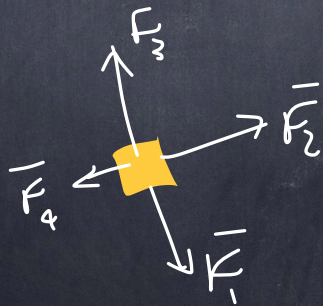
Forces:

A force is something that pushes or pulls an object.



Forces are vectors, and can be added.

What about this case?

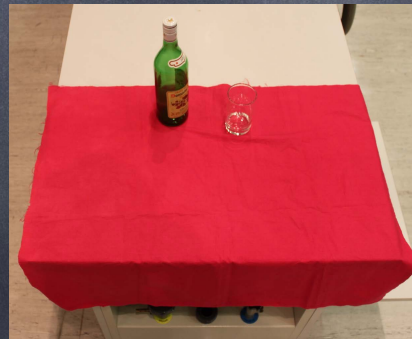
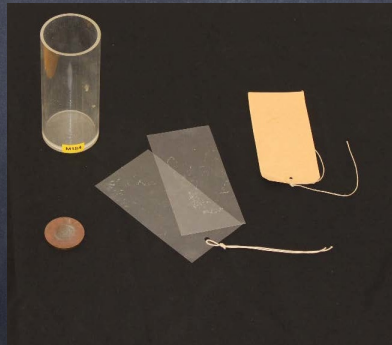


Newton's three laws for forces:

Law of inertia:

1) An object will remain at rest, or continue to move in a straight line, unless acted upon by a "net" force.

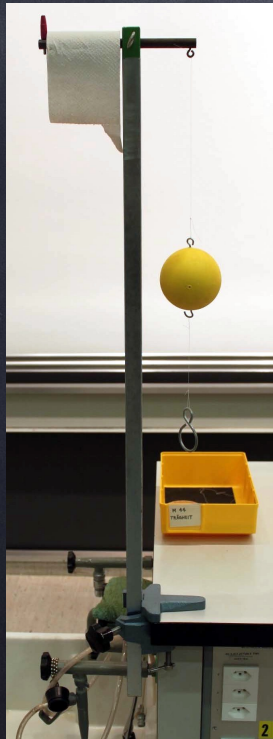
↑
non-zero



Second
Law:

2) A net force will cause an object to
accelerate according to $\Sigma \vec{F} = m \vec{a}$

Tests of Newton's first and second laws:



Newton's third law:

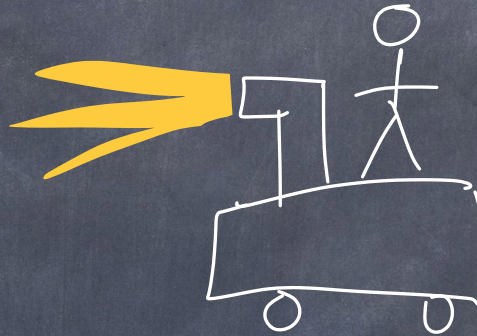
- 3) when one object exerts a force on a second object, the second object exerts a force, equal in magnitude, but opposite in direction, on the first object.

Examples :



third law: "action - reaction" law

Example 2:



Example 3:



Summary: Newton's three laws:

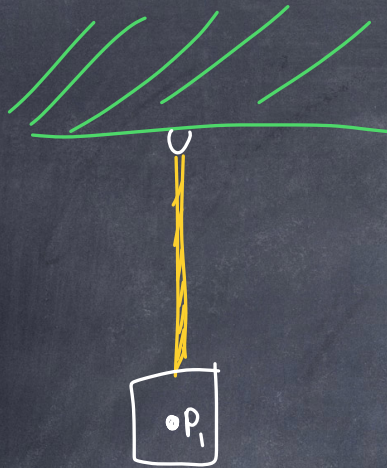
Law of inertia 1) An object will remain at rest, or continue to move in a straight line unless acted upon by a "net" force
↑
non-zero total force

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

2) A net force will cause an object to accelerate according to $\underline{\Sigma \vec{F} = m\vec{a}}$
↑
sum

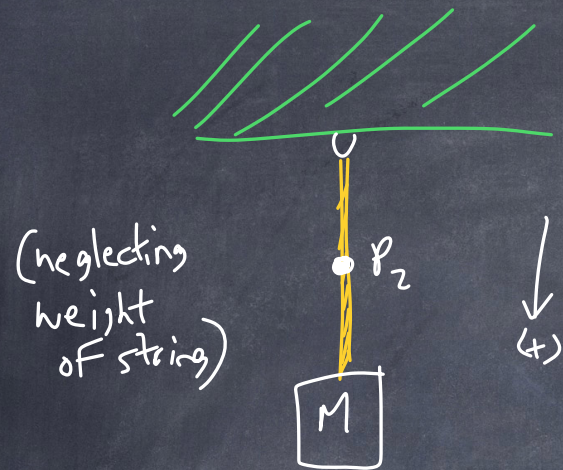
$$\underline{\vec{F}_{12} = -\vec{F}_{21}}$$

3) When one object exerts a force on a second object, the second object simultaneously exerts a force equal in magnitude but opposite in direction on the first object.
$$\vec{F}_{12} = -\vec{F}_{21}$$



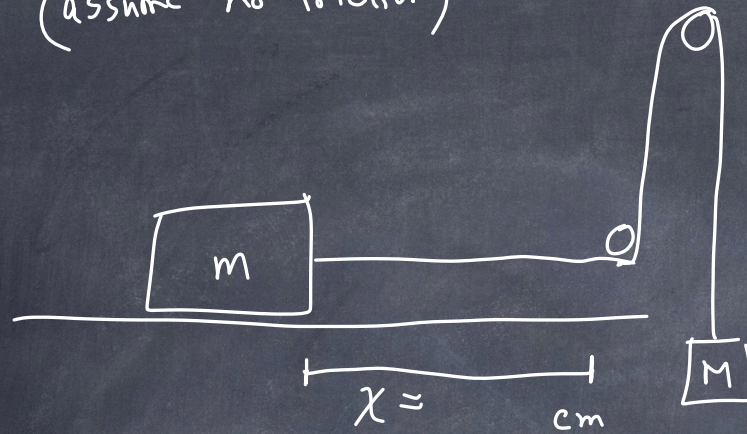
A mass M hangs from a
string to the ceiling.
Draw the forces acting
on P_1

what are the forces on P_2 ?



M : mass of block

(assume no friction)

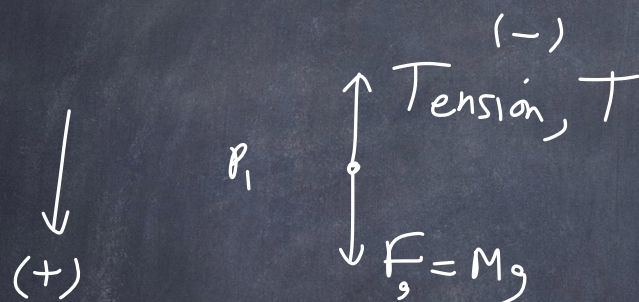
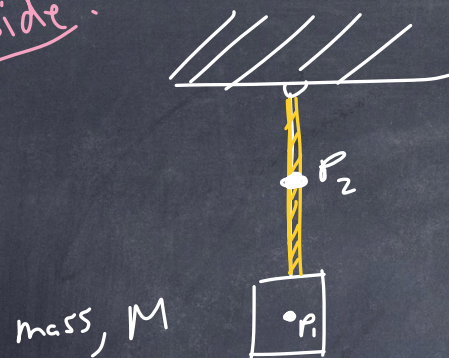


$m =$

$M =$



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

so $\vec{F}_g = M\vec{g}$

$\vec{T} = -M\vec{g}$

Exercise:

A mass M hangs from a string to the ceiling.

Draw the forces acting at P_1 .
What about P_2 ?

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

$$F_g = Mg \text{ in } (+) \text{ direction}$$

$$T = Mg \text{ in } (-) \text{ direction}$$

↖ ↗
In both cases F_g points down
& T points up.

Aside: Sometimes people write $\frac{df(x)}{dx}$ as $f'(x)$.
These two are the same.

$$\text{Since } \frac{df(x)}{dx} = f'(x) \Rightarrow df(x) = f'(x) dx$$

And if you take the integral
of both sides:

$$\int df(x) = \int f'(x) dx$$

This becomes:

$$f(x) = \int f'(x) dx$$

which is the definition of
an integral

$$\text{Also, } \frac{d^2 f(x)}{dx^2} = f''(x)$$

