PHY117 HS2026

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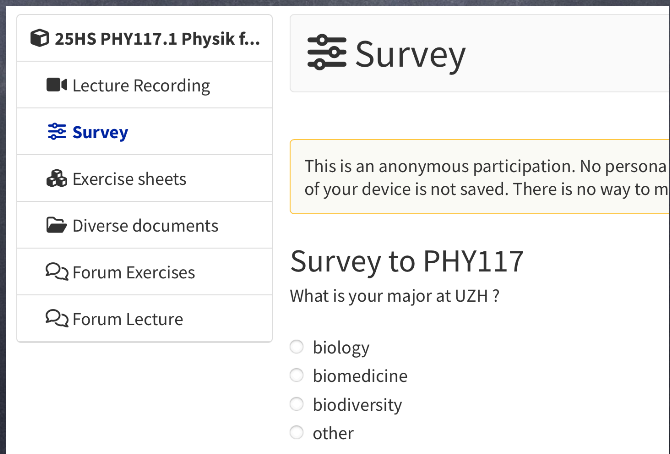
Sept. 16, 2026
Week 1, Lecture 2

Lecture notes here:
https://www.physik.uzh.ch/de/lehre/PHY117/HS2026.html

Make sure to complete survey:
https://lms.uzh.ch/
26HS PHY117.1
(takes just a few minutes)



Q: what are these: $\hat{x}, \hat{y}, \hat{z}$

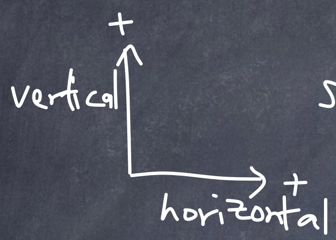
A: They are special vectors with length 1 called unit vectors

the "^" is called a "hat."

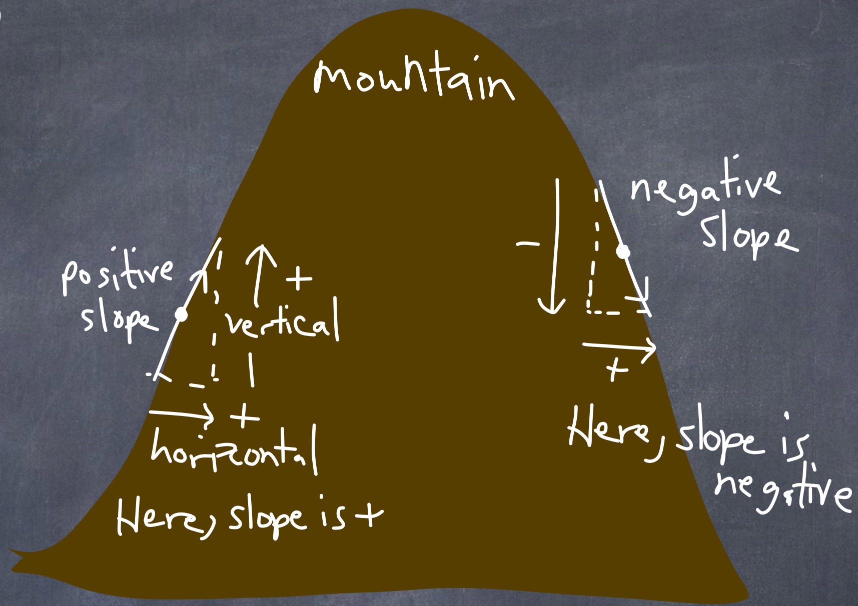
Unit vectors give us a coordinate system to define vectors.

Sometimes, people use $\hat{i}, \hat{j}, \hat{k}$ or $\hat{e}_1, \hat{e}_2, \hat{e}_3$.

Q: what is a slope?



$$\text{slope} = \frac{\text{vertical}}{\text{horizontal}}$$



Q: what is the difference between velocity + speed?

A: velocity is a vector
speed is a scalar

$$\text{velocity} = \bar{v} \begin{pmatrix} \text{magnitude} \\ + \\ \text{direction} \end{pmatrix}$$

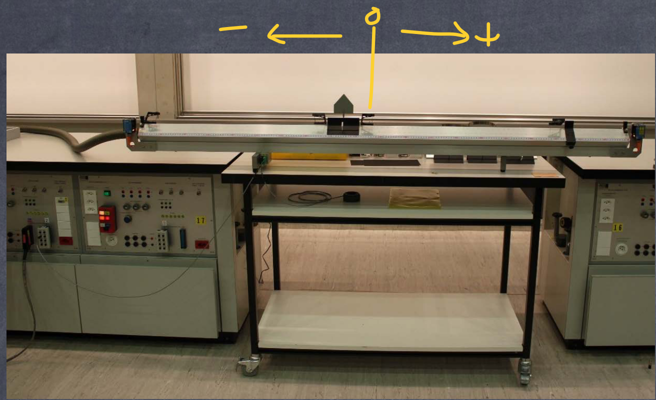
$$\text{speed} = v = |\bar{v}| \begin{pmatrix} \text{magnitude,} \\ \text{no direction} \end{pmatrix}$$

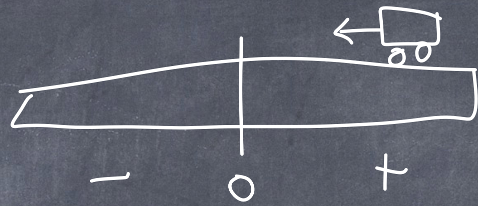
Example: $\begin{cases} \bar{v} = 3\,\frac{m}{s}\,\hat{x} \\ v = 3\,\frac{m}{s} \end{cases}$

Q: Reminder on derivatives: (useful for today)

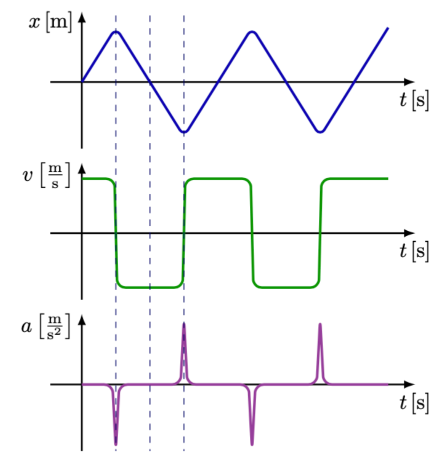
$$f(x) = \sin(x)$$

Explanation of yesterday's experiment:





Better diagram in script

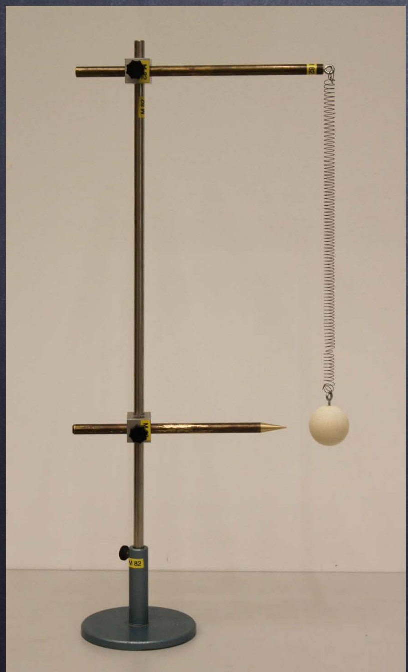


(f) Train bouncing back and forth with constant speed. The acceleration peaks when it quickly changed directions.

velocity is the slope of x vs. t

acceleration is the slope of v vs. t

Can we make our air-car accelerate more smoothly?



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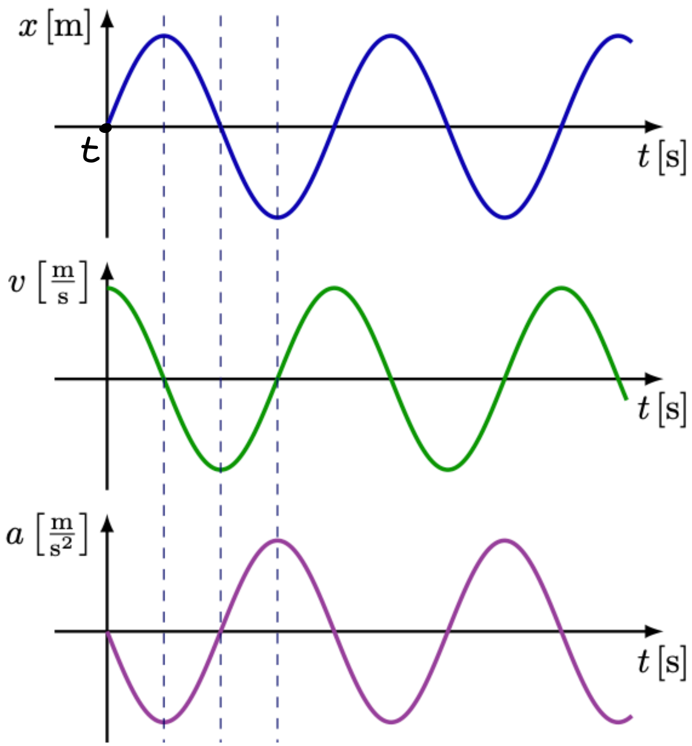
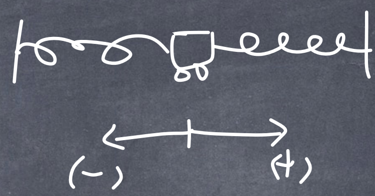


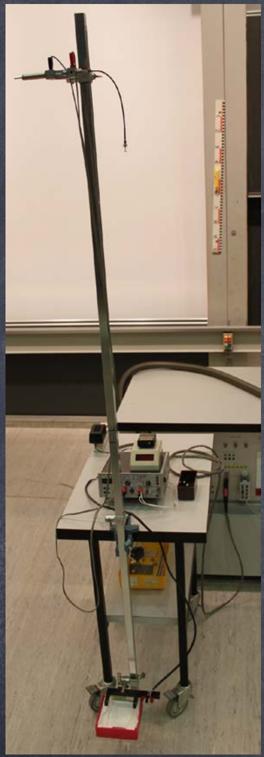
(g) Periodic one dimensional motion of a mass on a spring moving back and forth. Velocity is largest when $x = 0 = a$.



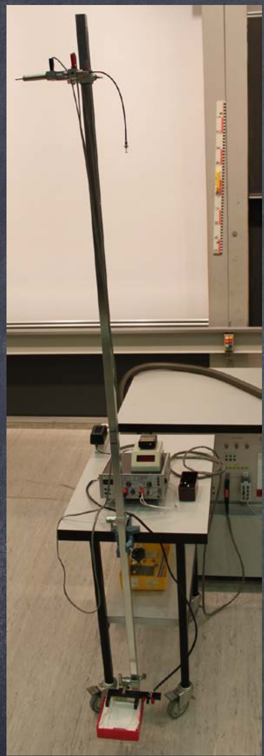
Motion with constant acceleration:

Does gravity accelerate everything the same?

what is g ? $\left[\frac{m}{s^2}\right]$



$+z$



z_0

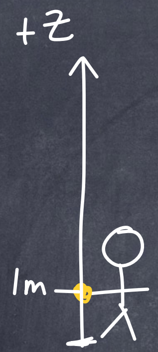
$h = 2.00 \pm 0.005\ \text{m}$

Example 2.4: For something more complicated like

$$f(x,y,a,b) = K\frac{xy^n}{ab^n}, \tag{2.16}$$

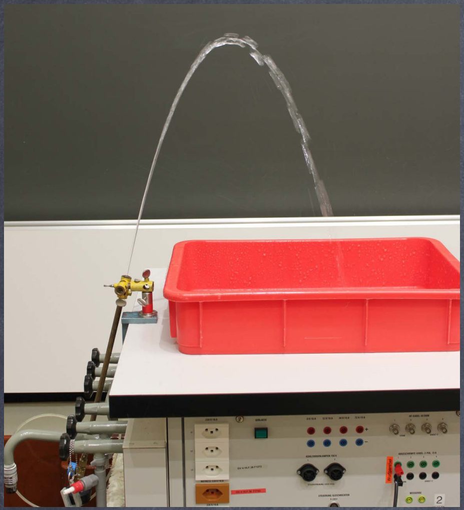
with a constant K, we find after some algebra

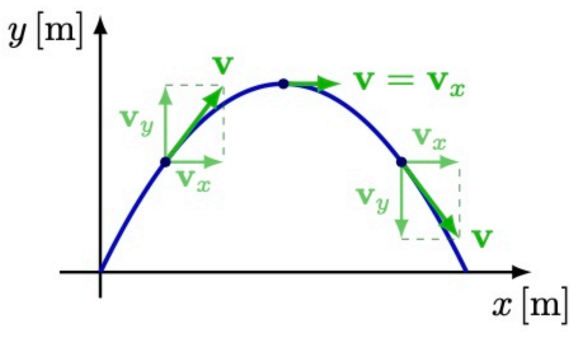
$$\sigma_f = |f|\sqrt{\left(\frac{\sigma_x}{x}\right)^2 + \left(\frac{\sigma_y}{y}\right)^2 + \left(\frac{n\sigma_a}{a}\right)^2 + \left(\frac{n\sigma_b}{b}\right)^2}, \tag{2.17}$$



Assume we throw a ball up at 20 m/s, what is its position and velocity in 4 s?

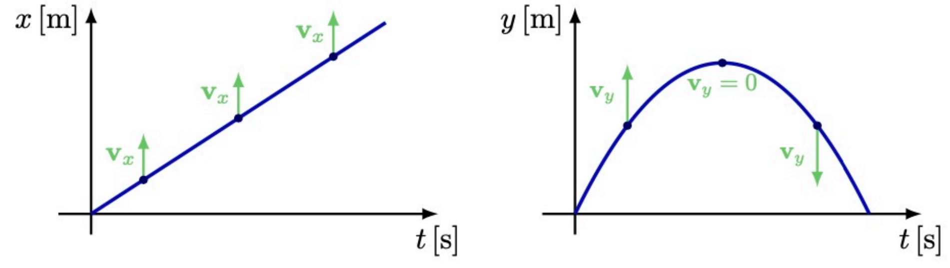
Motion in 2D:





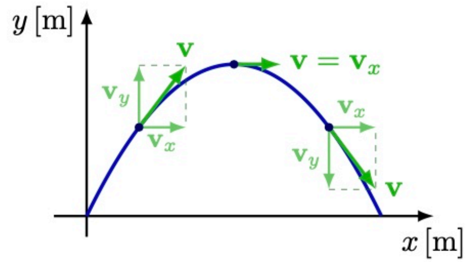
(c) *y*-*x* diagram.

Let's calculate the formulas for parabolic motion:



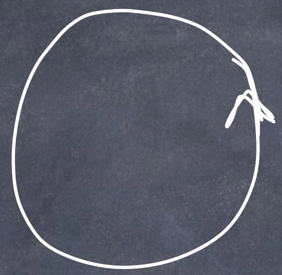
(a) x-t diagram.
(b) y-t diagram.

Diagram assumes $x_0 = y_0 = 0$



(c) y-x diagram.

Motion in a circle:



Circular motion (in 2D):

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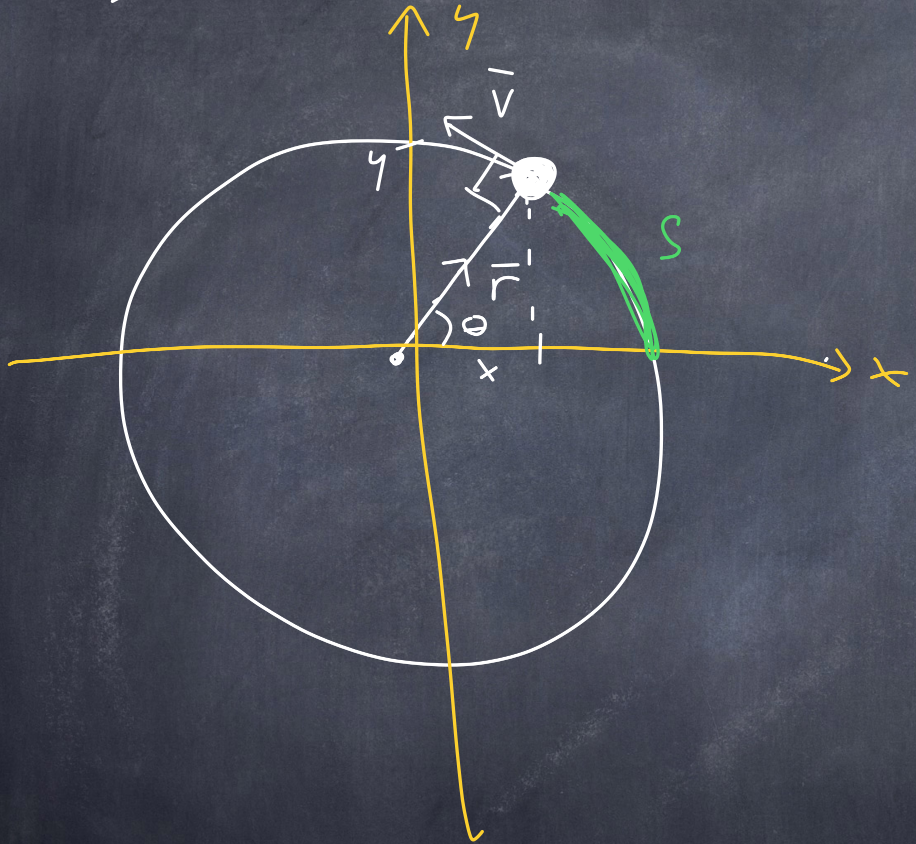
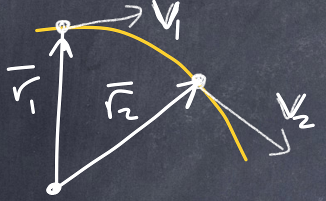


skip

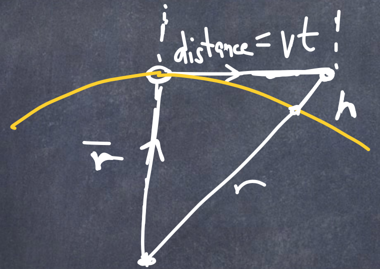
Motion in a circle. Ball on a string

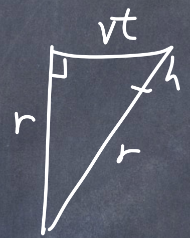
assumptions: The speed is the same vs. time

The velocity is changing (direction changes)



If the ball's velocity stayed the same, it would be at a height of $r+h$ after a time t.





Pythagorean theorem:

$$(vt)^2 + r^2 = (r+h)^2$$

$$(vt)^2 + \cancel{r^2} = \cancel{r^2} + 2rh + h^2$$

For small time t, h is small

h is very small compared to r $(h \ll r)$

so $h^2 \ll rh$

Therefore, $(vt)^2 \simeq 2rh + \cancel{h^2}^{\,0}$

so $h \simeq \frac{1}{2}\left(\frac{v^2}{r}\right)t^2$

Compare this to $t = \frac{1}{2}at^2$, we see that $\boxed{a = \frac{v^2}{r}}$

This is the centripetal acceleration. Movement in circle.

A satellite is moving around the earth at a height of 100 km above the ground. How long does it take to go around the earth?

$C_{earth} = 40{,}000 \text{ km}$

$g \sim 9.5 \frac{m}{s^2}$ at 100 km

Experiments