

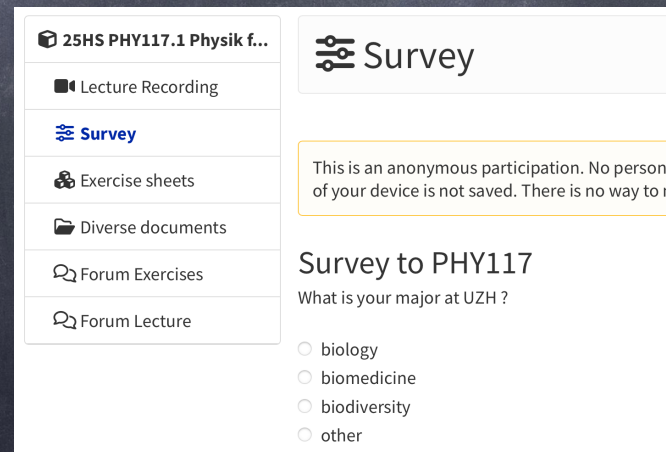
PHY117 HS2026

Prof. Ben Kilminster
Prof. Florencia Canelli
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](https://lms.uzh.ch/26HS PHY117.1)
(takes just a few minutes)



The screenshot shows a user interface for a course. On the left is a sidebar menu for '25HS PHY117.1 Physik f...' with options: 'Lecture Recording', 'Survey' (highlighted in blue), 'Exercise sheets', 'Diverse documents', 'Forum Exercises', and 'Forum Lecture'. On the right, the 'Survey' section is active, displaying a warning: 'This is an anonymous participation. No personal data of your device is not saved. There is no way to m...'. Below this is the title 'Survey to PHY117' and the question 'What is your major at UZH ?'. The answer options are: ☐ biology, ☐ biomedicine, ☐ biodiversity, and ☐ other.

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

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

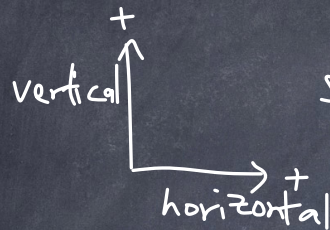


the "A" is called a "hat"

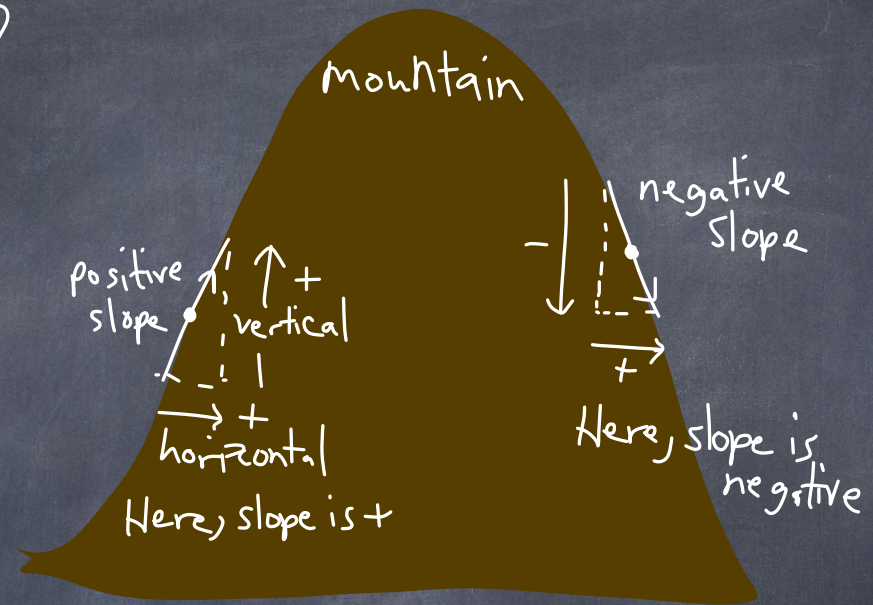
Unit vectors give us a coordinate system to define vectors.

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

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

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

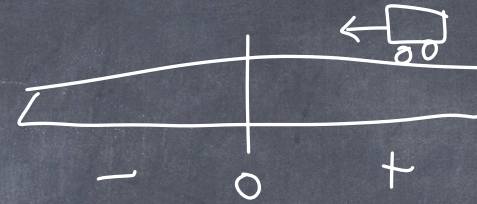
Example: $\begin{cases} \vec{v} = 3 \frac{\text{m}}{\text{s}} \hat{x} \\ v = 3 \frac{\text{m}}{\text{s}} \end{cases}$

Q: Reminder on derivatives: (useful for today)

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

Explanation of yesterday's experiment:

← 0 → +

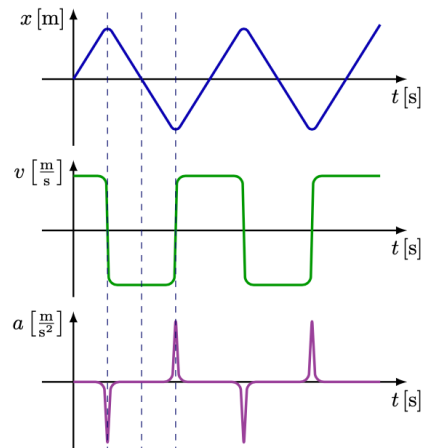


Better diagram
in script



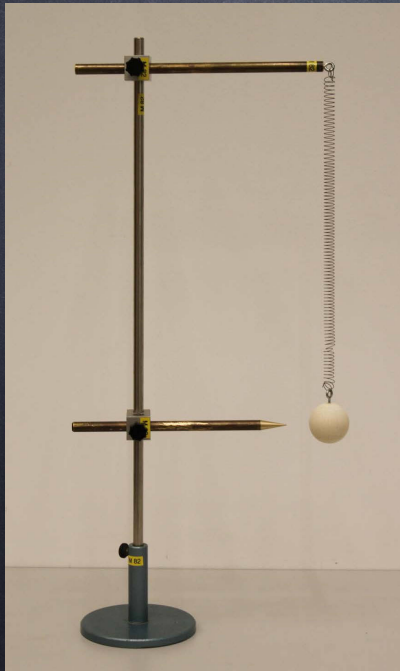
velocity is
the slope of
 x vs. t

acceleration
is the slope
of v vs. t



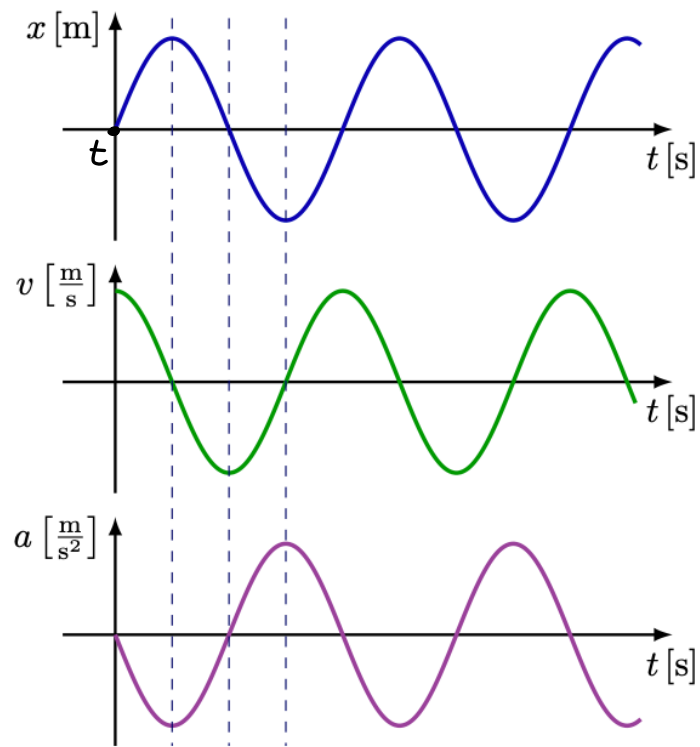
(f) Train bouncing back and forth with constant speed. The acceleration peaks when it quickly changed directions.

Can we make our air-car accelerate more smoothly?

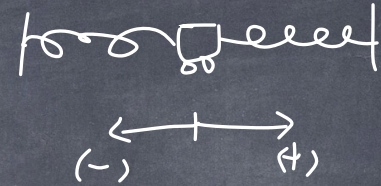




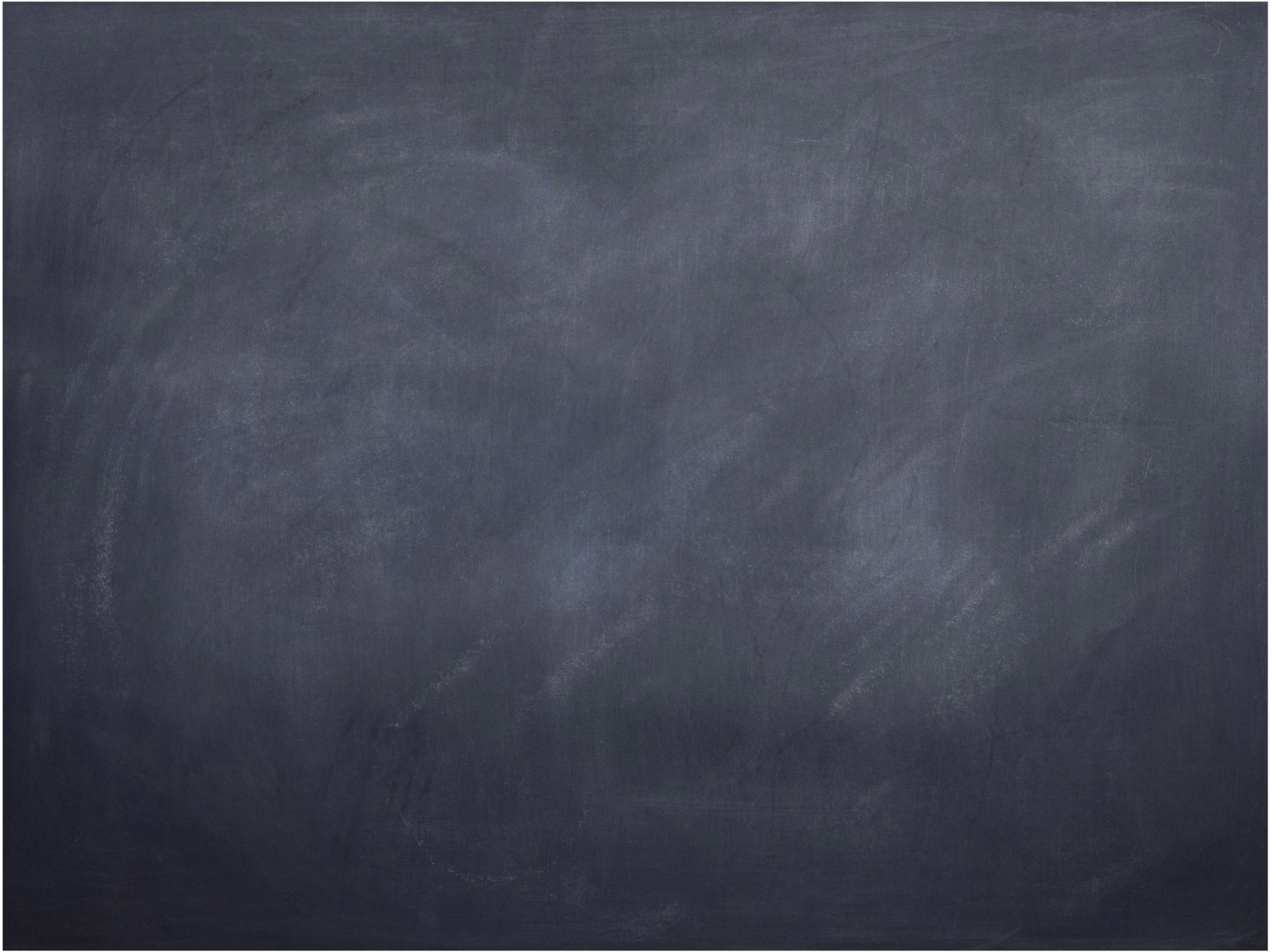
Can we make our air-car accelerate more smoothly?



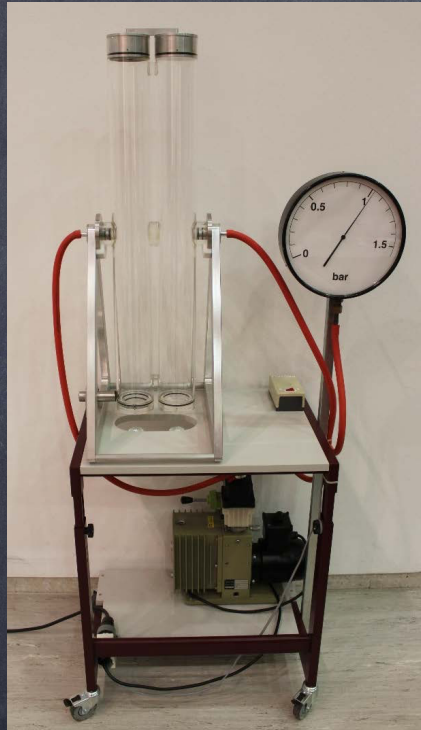
(g) Periodic one dimensional motion of a mass on a spring moving back and forth. Velocity is largest when $x = 0 = a$.



Motion with constant acceleration:

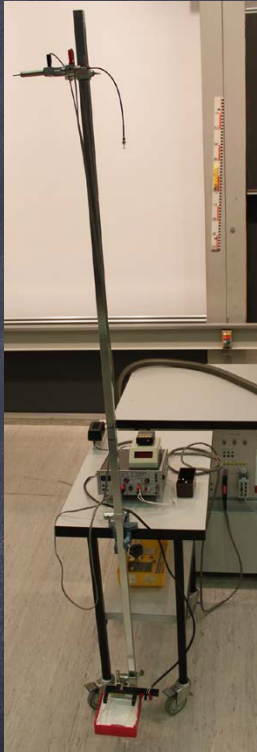


Does gravity accelerate everything the same?

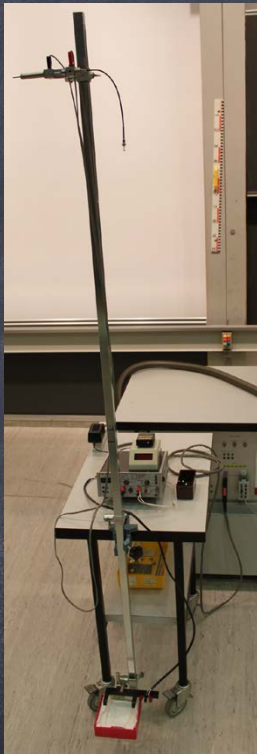


what is g ?

$$\left[\frac{\text{m}}{\text{s}^2} \right]$$



+z
↑



z₀

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

Example 2.4: For something more complicated like

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

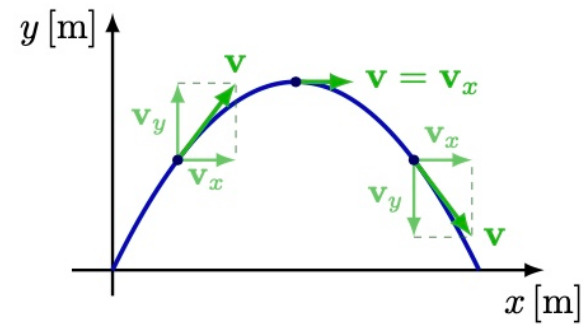
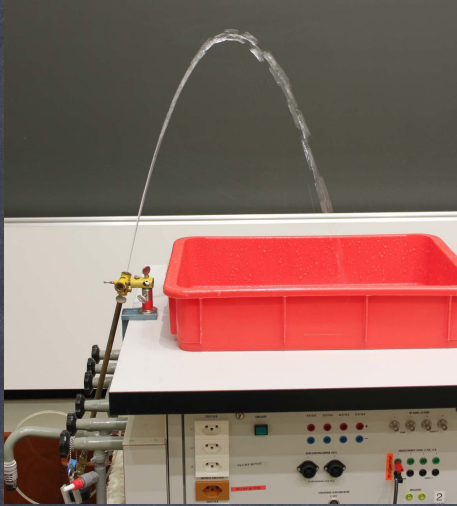
with a constant K , we find after some algebra

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



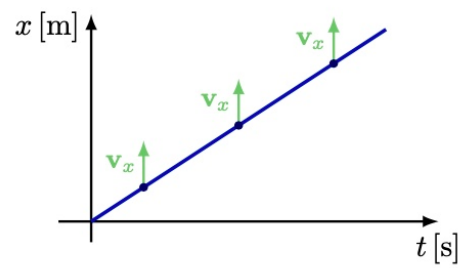
Assume we throw a ball up at 20 m/s , what is its position and velocity in 4.5?

Motion in 2D:

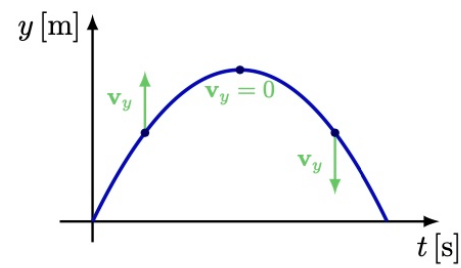


(c) y - x diagram.

Let's calculate the formulas for parabolic motion:

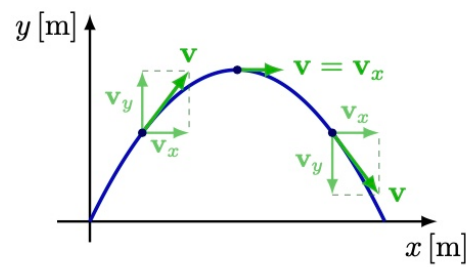


(a) x - t diagram.



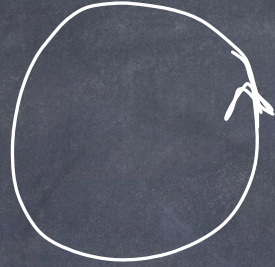
(b) y - t diagram.

Diagram
assumes
 $t_0 = y_0 = 0$



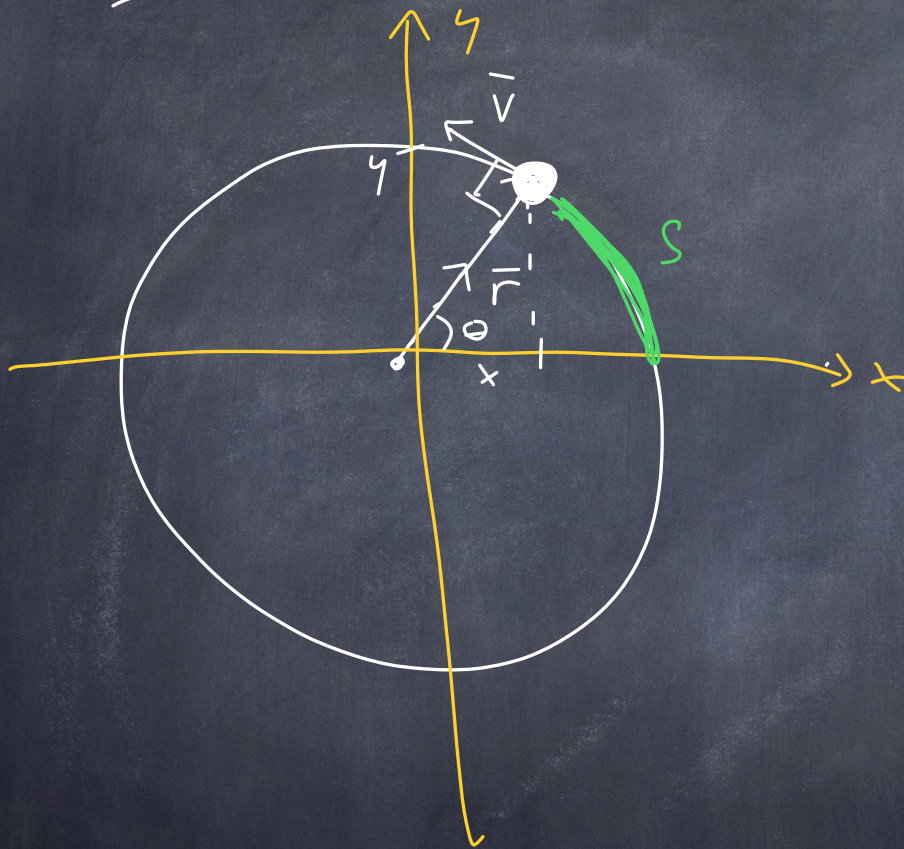
(c) y - x diagram.

Motion in a circle:



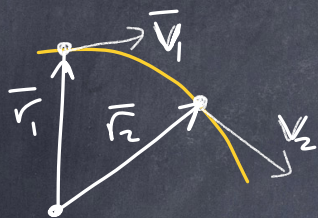
Circular motion (in 2D):

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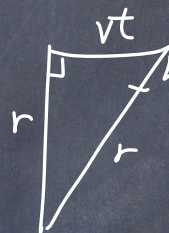
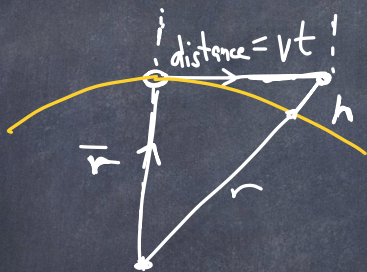


skip Motion in a circle, Ball on a string

assumption: 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 ($h \ll r$)

$$\text{so } h^2 \ll rh$$

$$\text{Therefore, } (vt)^2 \approx 2rh + \cancel{h^2}$$

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

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

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?

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

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



Experiments

