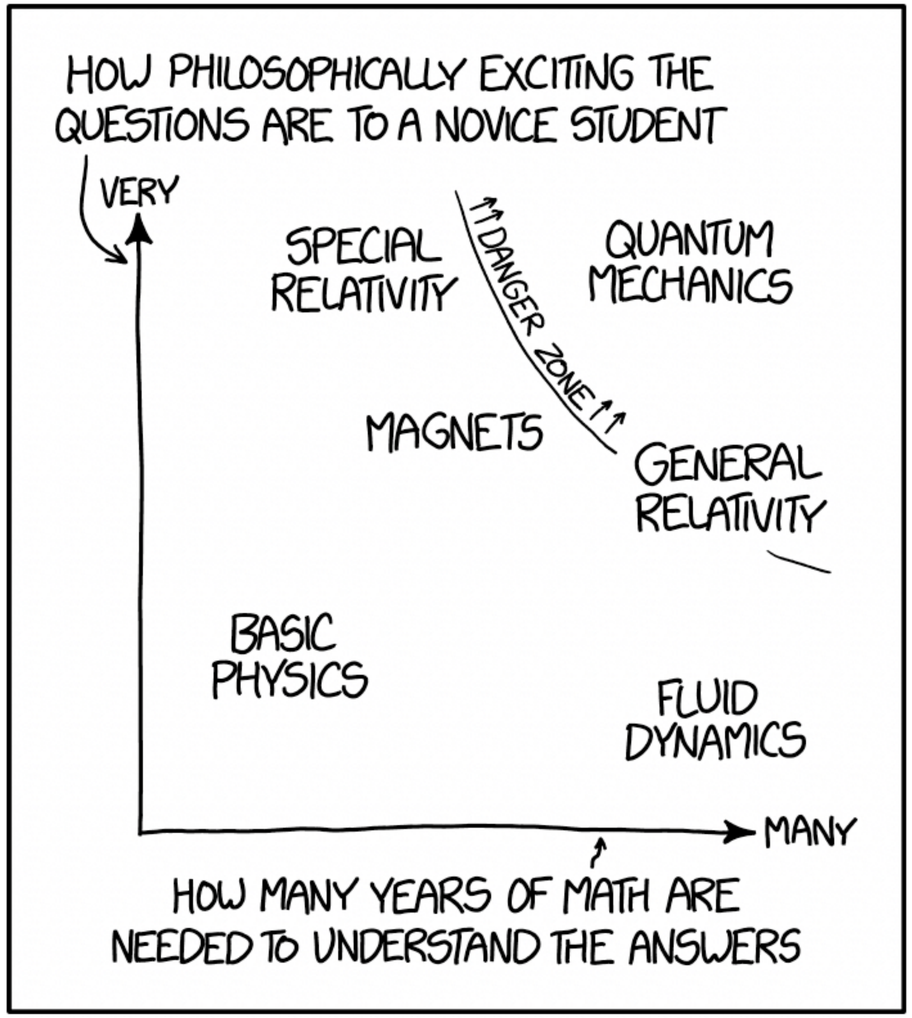
General Physics: Mechanics



https://xkcd.com/1861

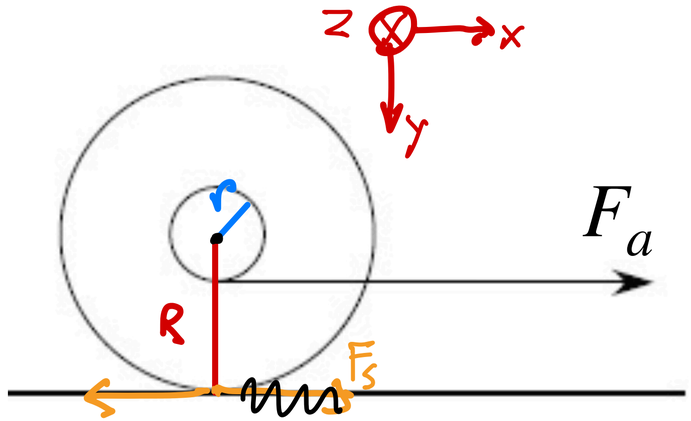
PHYS-101(en)

Lecture 14b: Review

Dr. Marcelo Baquero
marcelo.baquero@epfl.ch
December 16th, 2025

Example: Yo-yo (continued)

A yo-yo of mass m is placed on a rough surface and rolls without slipping. It is composed of two disks separated by a spindle with a smaller diameter. A string is wound around the spindle and pulled with a force F_a. In which direction does it move? To the right, winding up the string, or to the left, unwinding the string?



$$a_{CM} = (R-r)\left(\frac{I}{R}+mR\right)^{-1} F_a > 0$$

$$\Sigma F_x: F_a + F_s = m a_{CM} \Rightarrow F_s = m a_{CM} - F_a = m(R-r)\left(\frac{I}{R}+mR\right)^{-1} F_a - F_a$$

$$= F_a\left[m\frac{R-r}{\frac{I}{R}+mR} - 1\right] = F_a \frac{1}{\frac{I}{R}+mR}\left[m(R-r) - \left(\frac{I}{R}+mR\right)\right]$$

$$= F_a \frac{1}{\frac{I}{R}+mR}\left[\cancel{mR} - mr - \frac{I}{R} - \cancel{mR}\right] = -F_a \frac{1}{\frac{I}{R}+mR}\left(\frac{I}{R}+mr\right) < 0$$

Conceptual question

responseware.eu
Session ID: epflphys101en

Swiss Plasma Center

Which one of the following physical quantities is **not** a *vector*?

A. Position $\vec{r} = x\hat{x} + y\hat{y} + z\hat{z}$
B. Impulse $\vec{I} = \Delta\vec{p}$
C. Torque $\vec{\tau} = \vec{r} \times \vec{F}$
D. Work $W = \int_C \vec{F} \cdot d\vec{l}$
E. Displacement $\Delta\vec{r} = \vec{r}(t_f) - \vec{r}(t_i)$ where $t_f > t_i$

Conceptual question

responseware.eu
Session ID: epflphys101en

Swiss Plasma Center

Which one of the following *scalar* quantities **can** be negative?

A. Mass
B. Moment of inertia
C. Work
D. Kinetic energy
E. Spring constant

$m > 0$

$I = \int \rho^2 dm$

$W = \int_C \vec{F} \cdot d\vec{l}$

$\vec{F} \cdot d\vec{l} = F\, dl \cos(\theta) < 0$ if $\frac{\pi}{2} < \theta < \frac{3\pi}{2}$

$K = \frac{1}{2} m v^2$

$\kappa > 0$

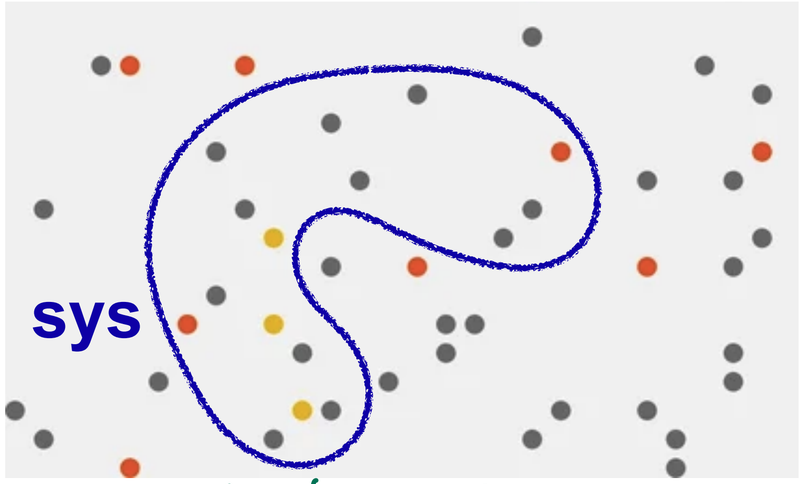
Conceptual question

responseware.eu
Session ID: epflphys101en

Swiss Plasma Center

The net *force* acting on sys (the physical system on the right) is

A. The largest force exerted on any point anywhere
B. The largest force exerted on any point in sys
C. Zero
D. The sum of all forces internal to sys
E. The sum of all forces exerted by points **not** in sys on points in sys



(Lecture 6a)

$$\vec{F}_{net} = \sum_{i \in sys} \sum_{j} \vec{F}_{ij}$$

$$= \sum_{i \in sys} \left[\sum_{j \in sys} \vec{F}_{ij} + \sum_{j \notin sys} \vec{F}_{ij} \right]$$

$$= \sum_{i \in sys} \sum_{j \in sys} \vec{F}_{ij} + \sum_{i \in sys} \sum_{j \notin sys} \vec{F}_{ij}$$

$$= \sum_{i \in sys} \sum_{j \notin sys} \vec{F}_{ij}$$

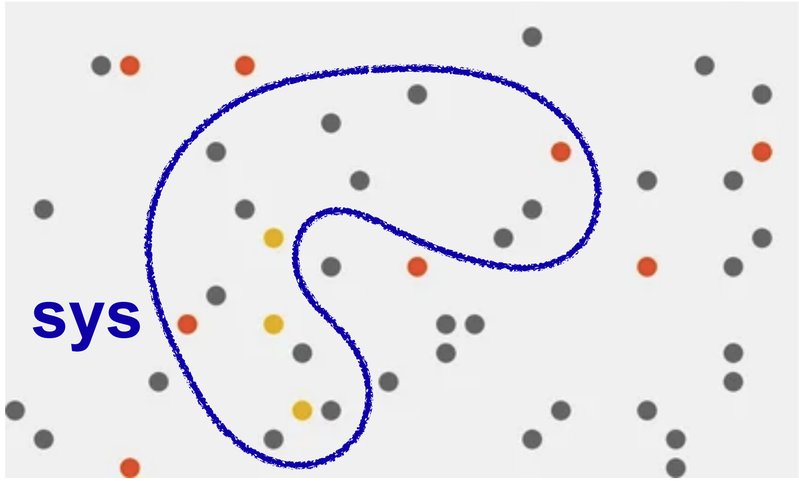
Conceptual question

responseware.eu
Session ID: epflphys101en

Swiss Plasma Center

We look at sys from an inertial reference frame and see that $\overrightarrow{F}_{net}^{ext} = 0$. There is no matter exchange with the outside. Which one of the following statements is **not** true?

Defi of "isolated system"



A. The internal forces add up to zero 3rd law
B. The total momentum of sys is conserved $\Delta\vec{p}_{tot}=0$ for isolated system
C. The momentum of each individual particle is guaranteed to stay constant
D. The position of the center-of-mass (CM) is well defined If always is
E. The velocity of the CM is constant

$$0 = \vec{F}_{net}^{ext} = M\vec{A}_{CM} \Rightarrow \vec{A}_{CM}=0$$

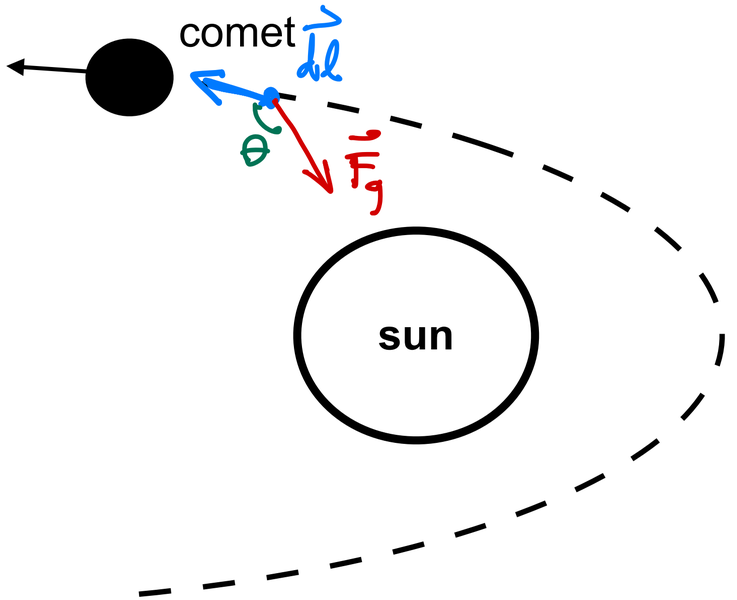
Conceptual question

responseware.eu
Session ID: epflphys101en

Swiss Plasma Center

A comet is on a hyperbolic orbit around the Sun. While the comet is moving away from the Sun, the work done by the Sun on the comet is…

A. positive.
B. zero.
C. negative.



$\vec{F}_g \cdot \vec{dl} = F dl \underbrace{\cos(\theta)}_{<0}$

because $\frac{\pi}{2} < \theta < \frac{3\pi}{2}$

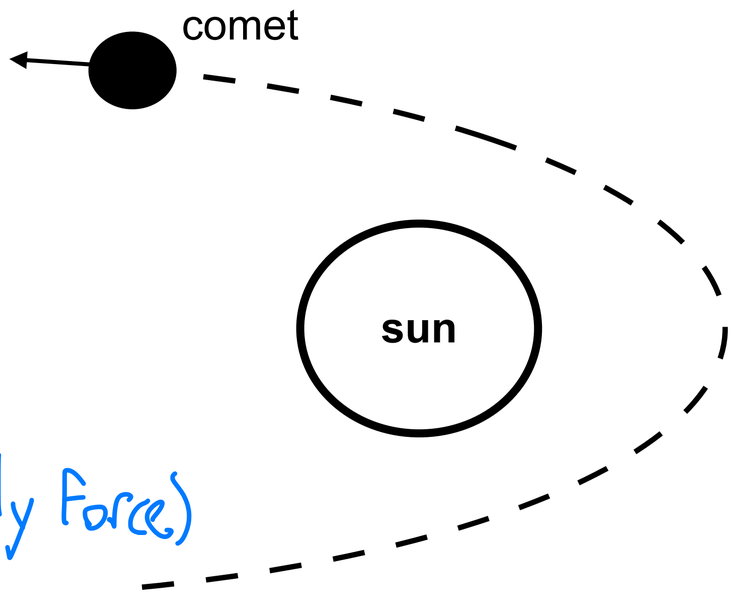
Conceptual question

responseware.eu
Session ID: epflphys101en

Swiss Plasma Center

A comet is on a hyperbolic orbit around the Sun. While the comet is moving away from the Sun, what happens with its speed?

A. It increases
B. It stays the same
C. It decreases
D. There is not enough info



$\Delta K = W_{net} = W_g$ (gravity is only force)

$\Delta K = W_g < 0$

Conceptual question

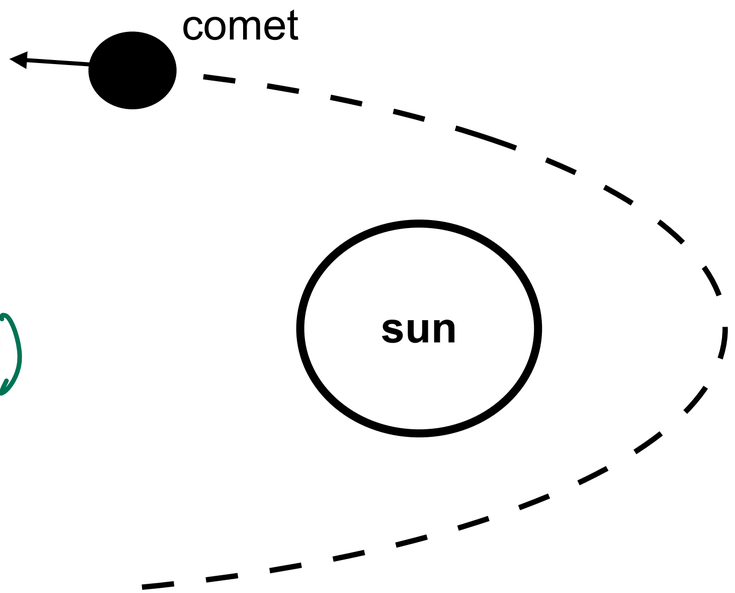
responseware.eu
Session ID: epflphys101en

Swiss Plasma Center

A comet is on a hyperbolic orbit around the Sun. While the comet is moving away from the Sun, what happens with its gravitational potential energy?

A. It increases
B. It stays the same
C. It decreases
D. There is not enough info

$\Delta U_g = -W_g > 0$ (because $W_g < 0$)

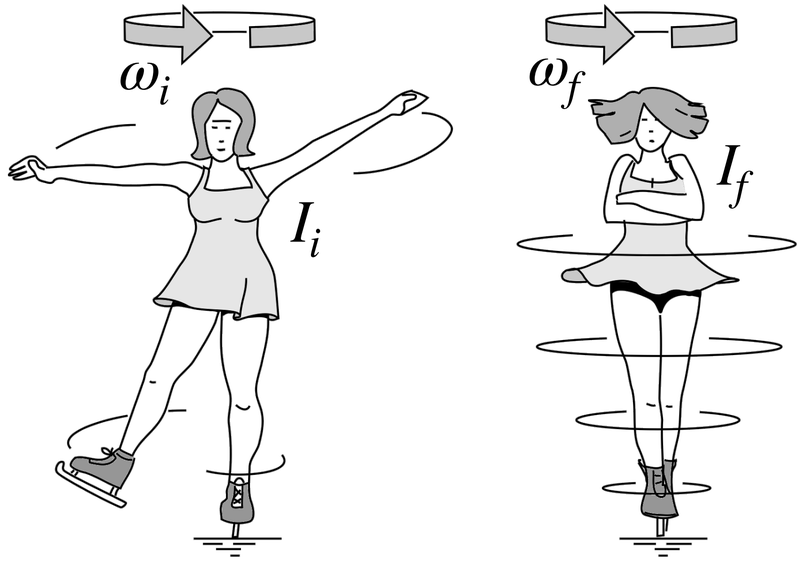


Conceptual question

responseware.eu
Session ID: epflphys101en

Swiss Plasma Center

A figure skater stands on one spot on the ice (assumed frictionless) and spins around with her arms extended. When she pulls her arms in, she reduces her moment of inertia and her angular speed increases. Compared to her initial **angular momentum**, her **angular momentum** after she has pulled her arms in must be…



A. the same.
B. larger.
C. smaller.

No external torque $\Rightarrow \Delta \vec{L}_{tot} = 0$

Happy holidays and good luck in the Final Exam!

(Do not forget to check the Moodle for the rooms of the Review sessions)