

Today:

torque - applications to NMR, MRI
angular momentum - applications to chemistry, NMR, MRI (electron orbits)
rotational inertia - applications to chemistry (heat capacity)
precession - applications to NMR, MRI

Also, new topic:

pressure
atmospheric pressure
fluids

PHY 117 HS2026

Week 4, Lecture 2

Oct. 7th, 2026

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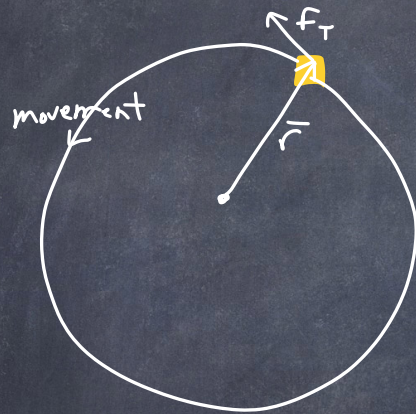
Remember to
do quizzes 1,2,3,4
on OLAT.

Stats

students:	700
quiz 1 :	267
quiz 2 :	238
quiz 3 :	76

Yesterday:

Consider a tangential force on an object, mass m , constrained to move in a circle.



The force is tangential, F_T

The force is unbalanced, creates a .

$$F_T = ma = m(r\alpha)$$

$a = r\alpha$
for circular motion.

we multiply both sides by r

$$r F_T = \underbrace{mr^2}_{\tau} \alpha$$

$$\tau = I \alpha$$

$$\tau = I \alpha$$

$I \equiv mr^2$: "moment of inertia": this is for a particle of mass m at a radius r from the center of rotation.

Yesterday:

Note: the parallels between linear + rotational motion:

linear motion

$$F = ma$$

rotational motion

$$\tau = I \alpha$$

I is like mass $\uparrow$ angular acceleration
($I = mr^2$)

Newton's
2nd law

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

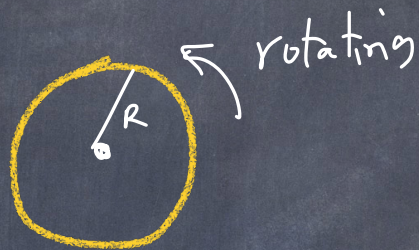
Newton's second law

of rotation

$$\Sigma \vec{\tau} = I \vec{\alpha}$$

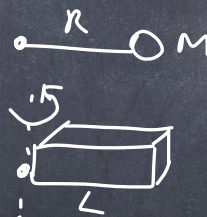
I is a measure of how mass is distributed.

Simple case: ring
total mass M , all at
a radius R



shape
point
ring
stick
sphere
disk

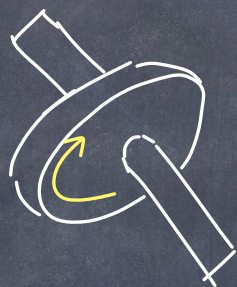
$$\begin{aligned} I & \\ \hline I &= MR^2 \\ I &= MR^2 \\ I &= \frac{1}{3} ML^2 \\ I &= \frac{2}{5} MR^2 \\ I &= \frac{1}{2} MR^2 \end{aligned}$$



$$\vec{\tau} = \mathbf{I} \vec{\alpha}$$

what direction is $\vec{\alpha}$?

$\vec{\alpha}$ points in same
direction as $\vec{\tau}$



speeding up

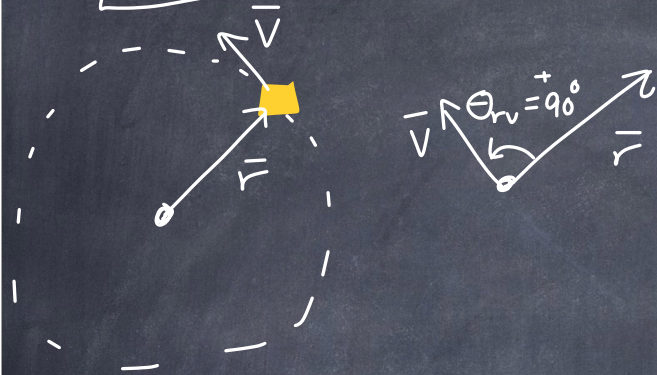


slowing down

Derivation of angular momentum from linear momentum

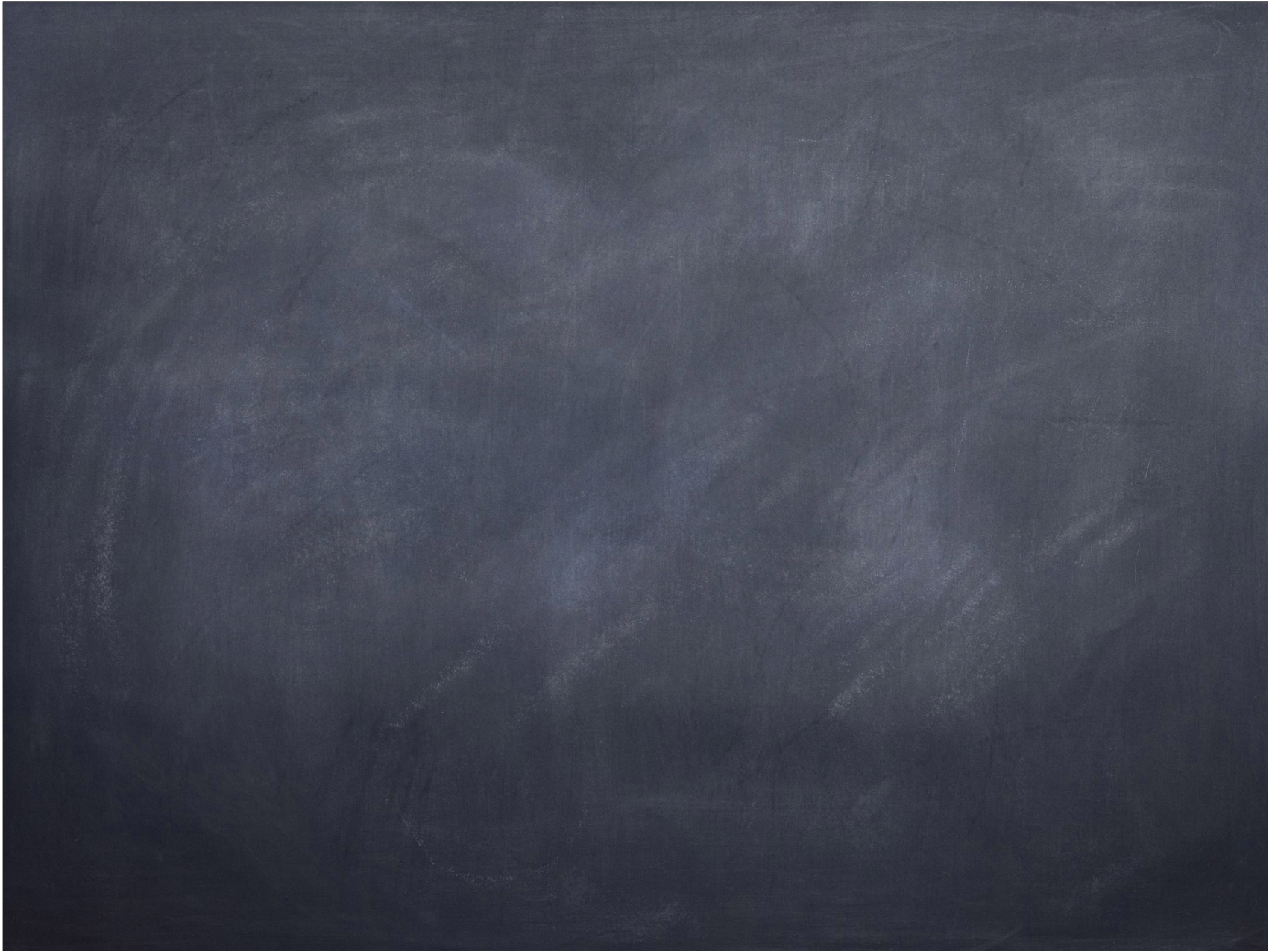
In linear motion, we have $\vec{p} = m\vec{v}$

Angular momentum $\vec{L} = \vec{r} \times \vec{p}$





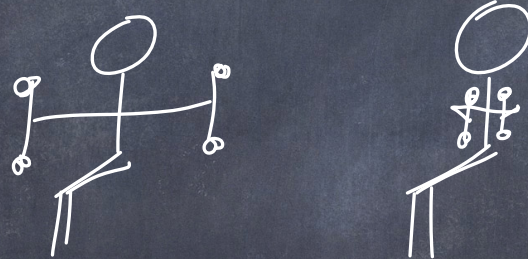
Direction of angular momentum
of the second hand of SBB
clock?



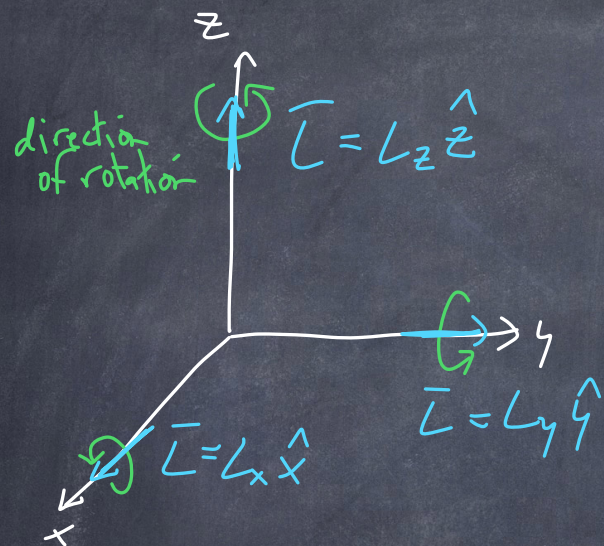
so $\bar{L}$ is conserved like $\bar{p}$

$$\bar{L} = I \bar{\omega}$$

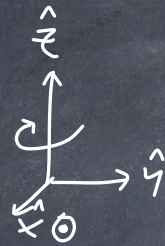
this means that if we change I , then ω must also change ω for $\bar{L}$ to remain constant.



Objects can spin around 3 axes.



we have a chair that
can spin only around $\hat{z}$ -axis



Now, I hold wheel
with angular momentum
in $\hat{x}$ -direction



①

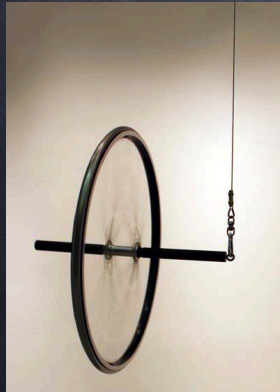
then, I rotate wheel
to have L_z component.

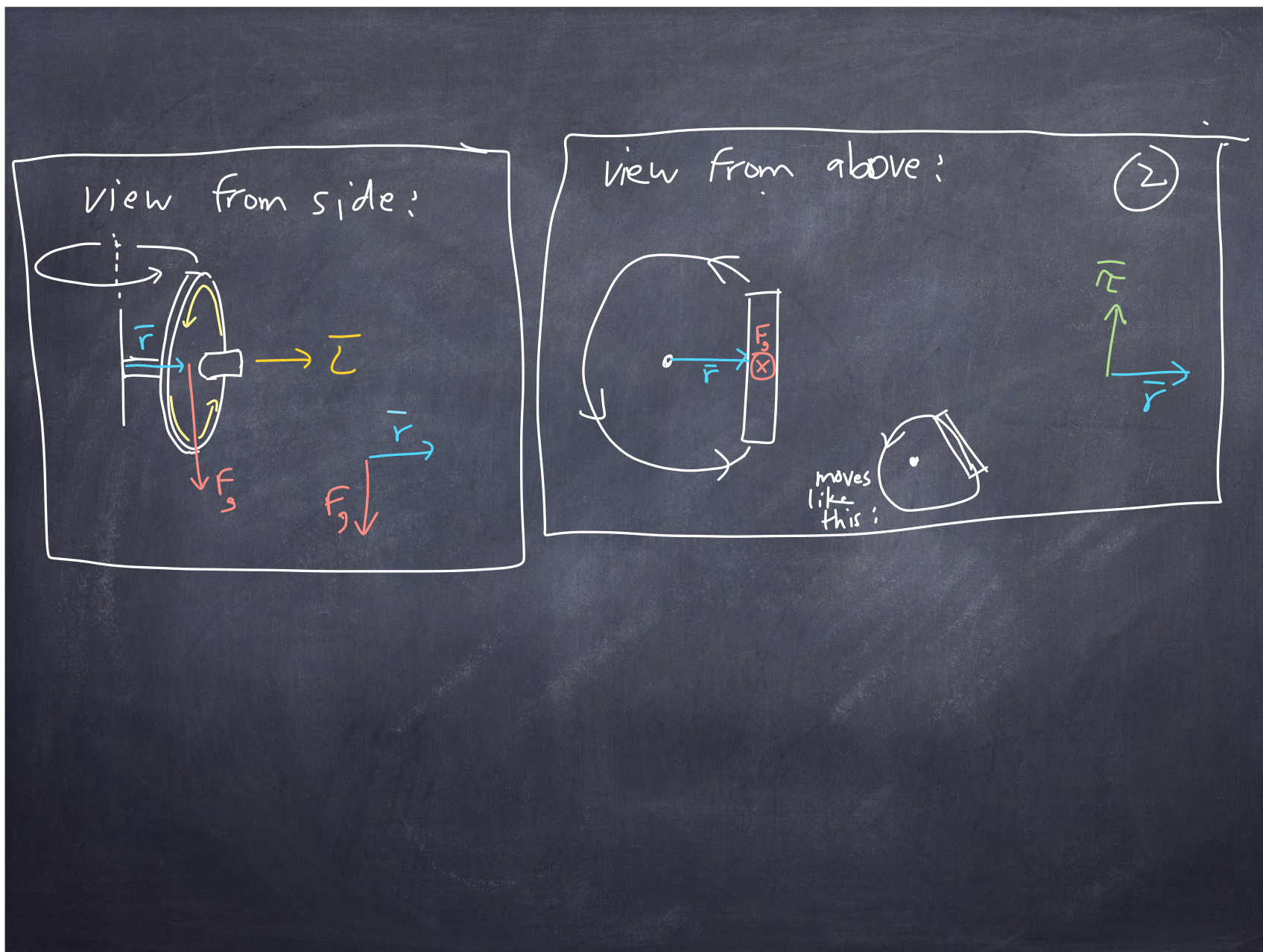


②

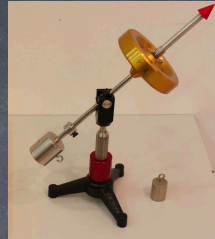
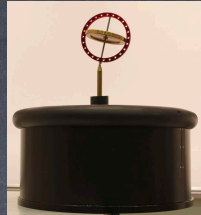
What happens?

precession





How Fast does it process?

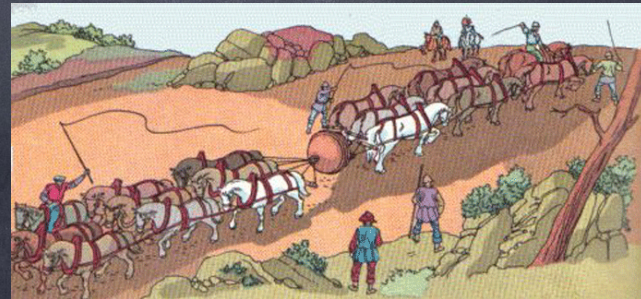
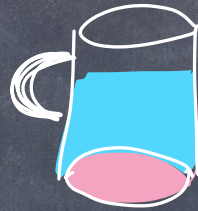
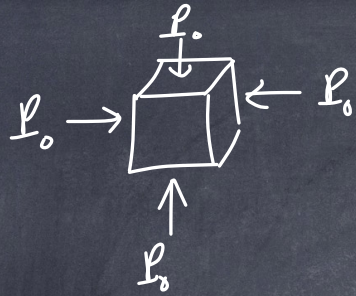


Angular momentum, torque, + precession
will come up in NMR + MRI
(we will discuss in PHY 127)

New topic: Fluids

we start by defining pressure
and doing some measurements.

what is pressure?



where does pressure come from?

