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SCIENCE
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ELECTRICAL ROTATING PLATFORM

1443

Electrical rotating platform

Optika rotating platform allows students not only to verify the relations between the fundamental quantities which characterize rotational motion, but also to perform experiments on an important topic: inertial and non-inertial systems.
What is seen by an observer on an inertial system is different from what is seen by an observer on a non-inertial system.
In this way students are allowed to understand which is the origin and which are the results of fictitious forces as the centrifugal force and Coriolis force.

Thanks to this platform, you are able to study a lot of fundamental topics as the effects of Coriolis force on solids and liquids and understand why a mathematical instrument as the cross product was so important.
By which magnitudes the centrifugal force depends on? Let's perform some experiences with OPTIKA rotating platform.

1. *Centripetal force*
2. *A fictitious force: the centrifugal force*
3. *Lack of centripetal force: what happens?*
4. *Centrifugal forces in equilibrium*
5. *How to use centrifugal force to separate a mixture*
6. *How to use centrifugal force to dry linen*
7. *Centrifugal force and Earth shape*
8. *Watt's regulator*
9. *White light: Newton's Disk*
10. *Conical pendulum*
11. *Properties of conical pendulum*
12. *How to verify centripetal and centrifugal forces formula*
13. *Another fictitious force: Coriolis force*
14. *Coriolis force acting on a water jet*
15. *Coriolis force acting on a pendulum*
16. *Observer in a non-inertial system*
17. *How to verify Coriolis law with an experiment*
18. *When Coriolis force is zero*
19. *Foucault's pendulum*

Technical data

Power supply:
- Input 100-240 V AC 50/60 Hz, 1.0-0.5 A
- Output 12 V CC, 3.34 A, 40 W max

Platform diameter 400 mm
Height 235 mm ca - adjustable feet

Control unit
Velocity, LOW mode:
- Minimum rpm > 15 rpm
- Maximum rpm < 80 rpm

Velocity, HIGH mode:
- Minimum rpm > 15 rpm
- Maximum rpm < 260 rpm

Rpm measured using a photogate:
- Error < 3%

Controller:
- Clockwise/counterclockwise rotation
- Velocity mode LOW/HIGH

Speed continuously adjustable

PEAK function:
- To visualize the maximum speed reached.

Accessories (not included in the code 1443)

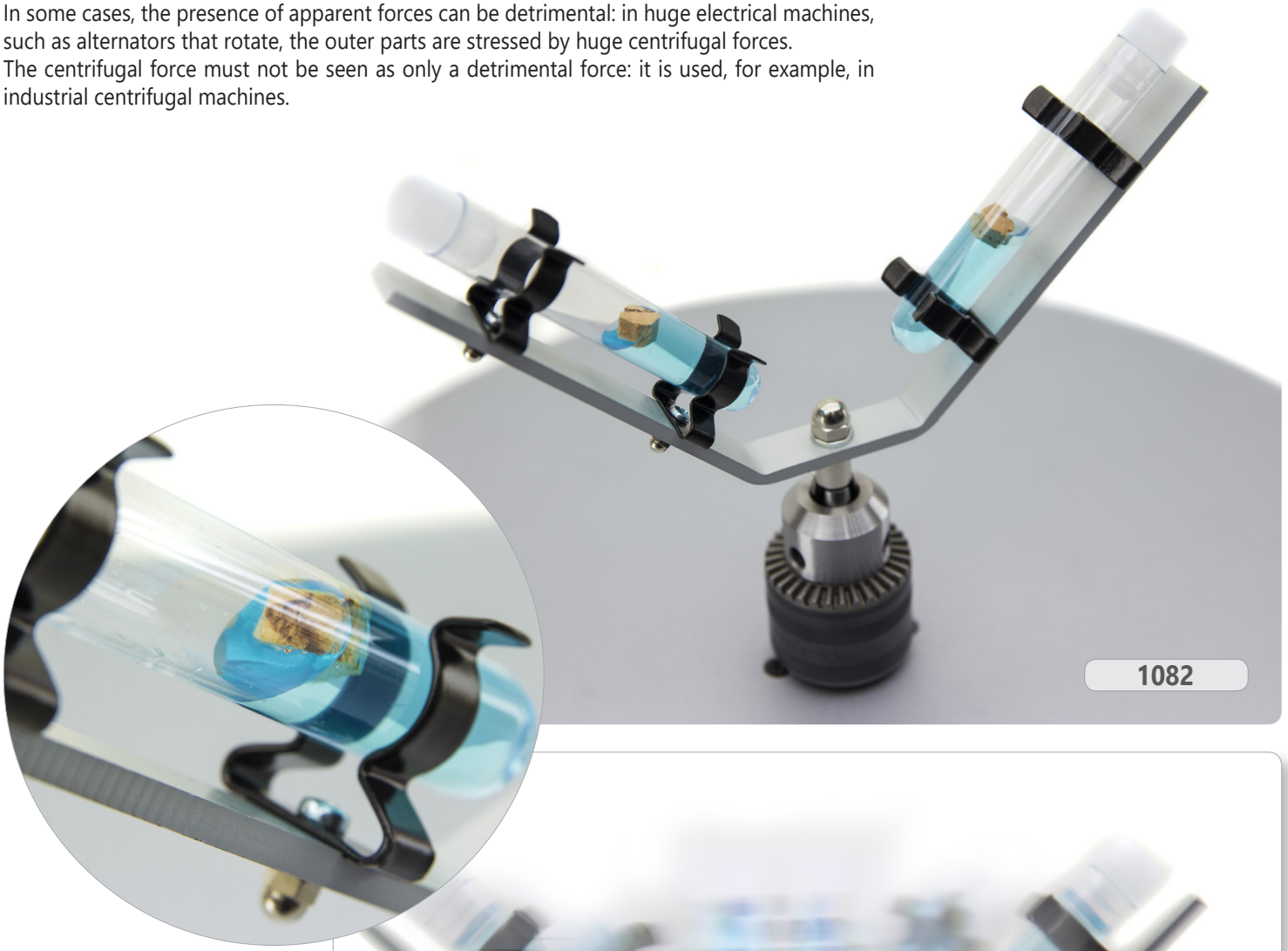
1455 Camera Kit

See the experiment as if you were on the non-inertial system.
This camera kit code 1455 allows you to make video with a smartphone: observe the experiment from another interesting point of view.
This camera kit can be used with all the accessories of the rotating platform.

Warning: to be used only with velocity in LOW range.
The clamp shown in the photo is a smartphone support. We recommend to use a smartphone provided by our company.
Please, contact our sales department for more information.

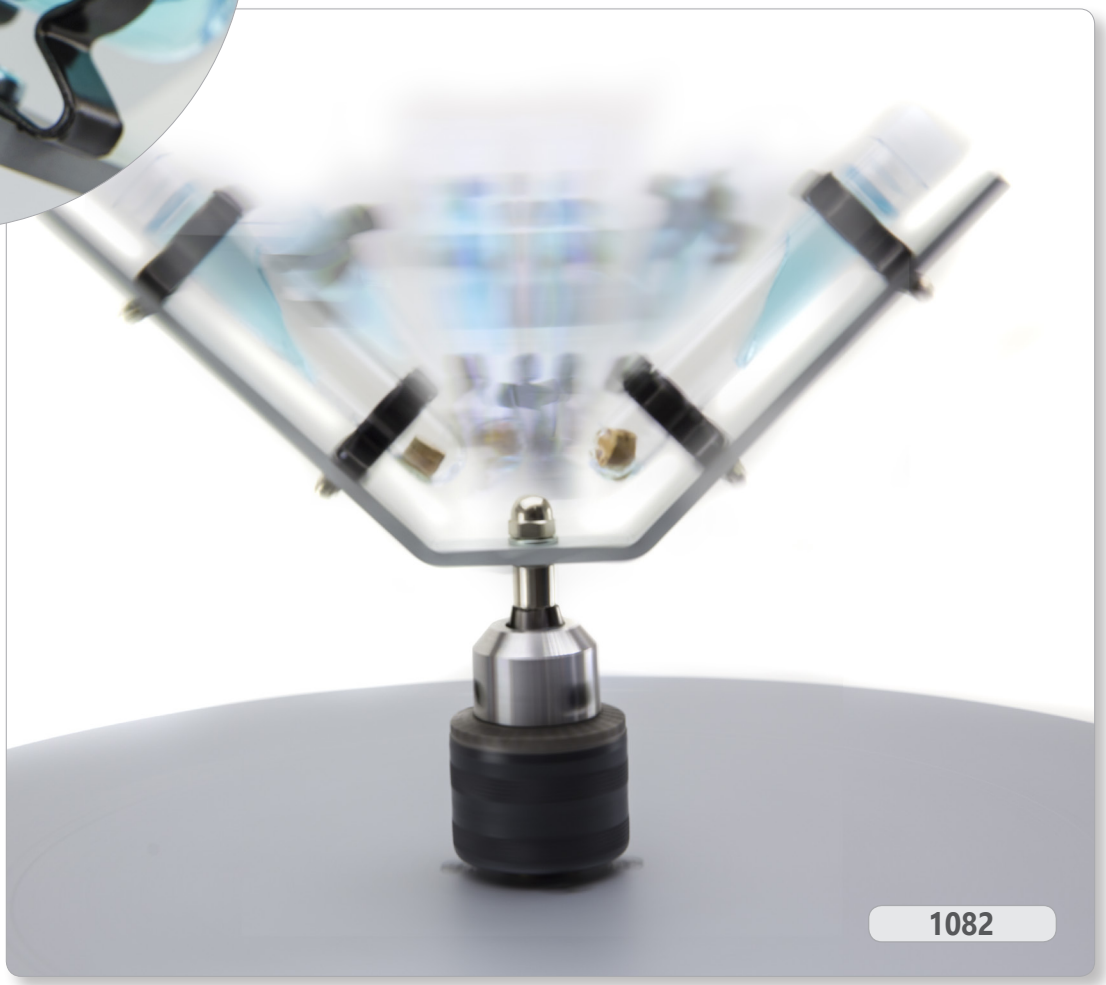
1082 Centrifugal force

As all the apparent forces, the centrifugal force produces dynamic effects entirely equivalent to those of the real forces.
In some cases, the presence of apparent forces can be detrimental: in huge electrical machines, such as alternators that rotate, the outer parts are stressed by huge centrifugal forces.
The centrifugal force must not be seen as only a detrimental force: it is used, for example, in industrial centrifugal machines.



These machines are used in various fields: to separate the particles in suspension in a liquid (such as milk centrifugation), to accelerate processes of filtration, precipitation and settling in industrial chemistry, to separate the liquid and solid phases of lubricating oils, etc.

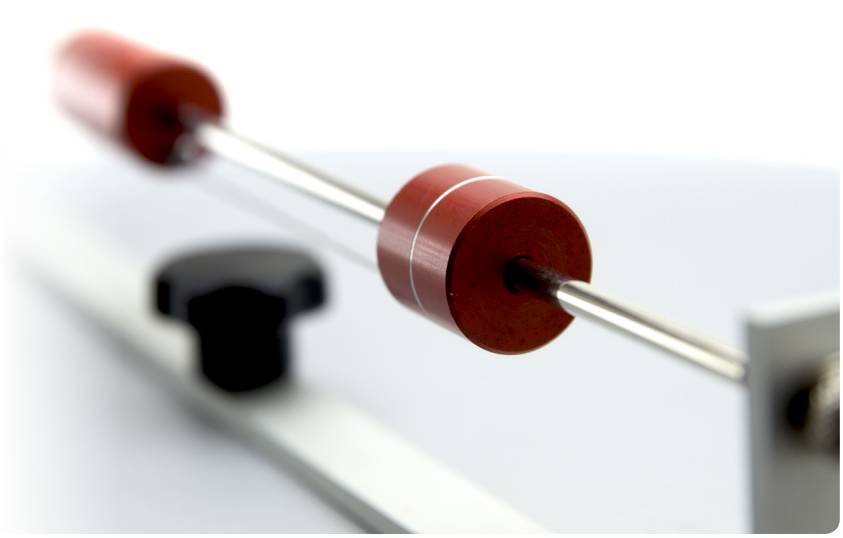
In all these cases, it exploits the fact that, being the centrifugal force proportional to the mass of the rotating body, the particles, having equal volume, that have a greater mass are separated from those of lower mass.

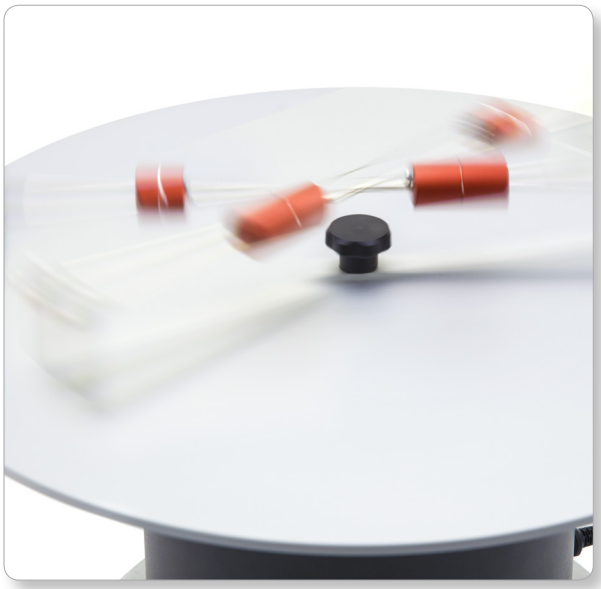


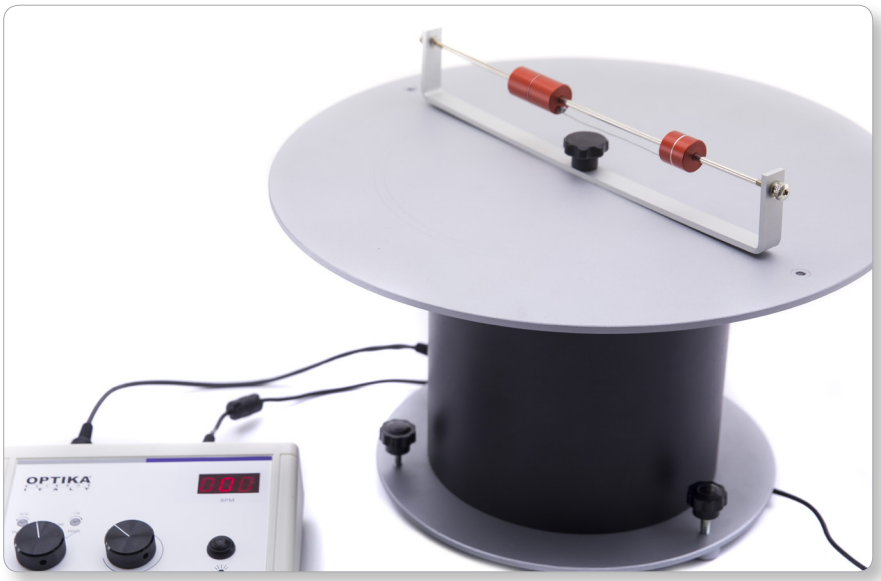
1447 Centrifugal forces in equilibrium

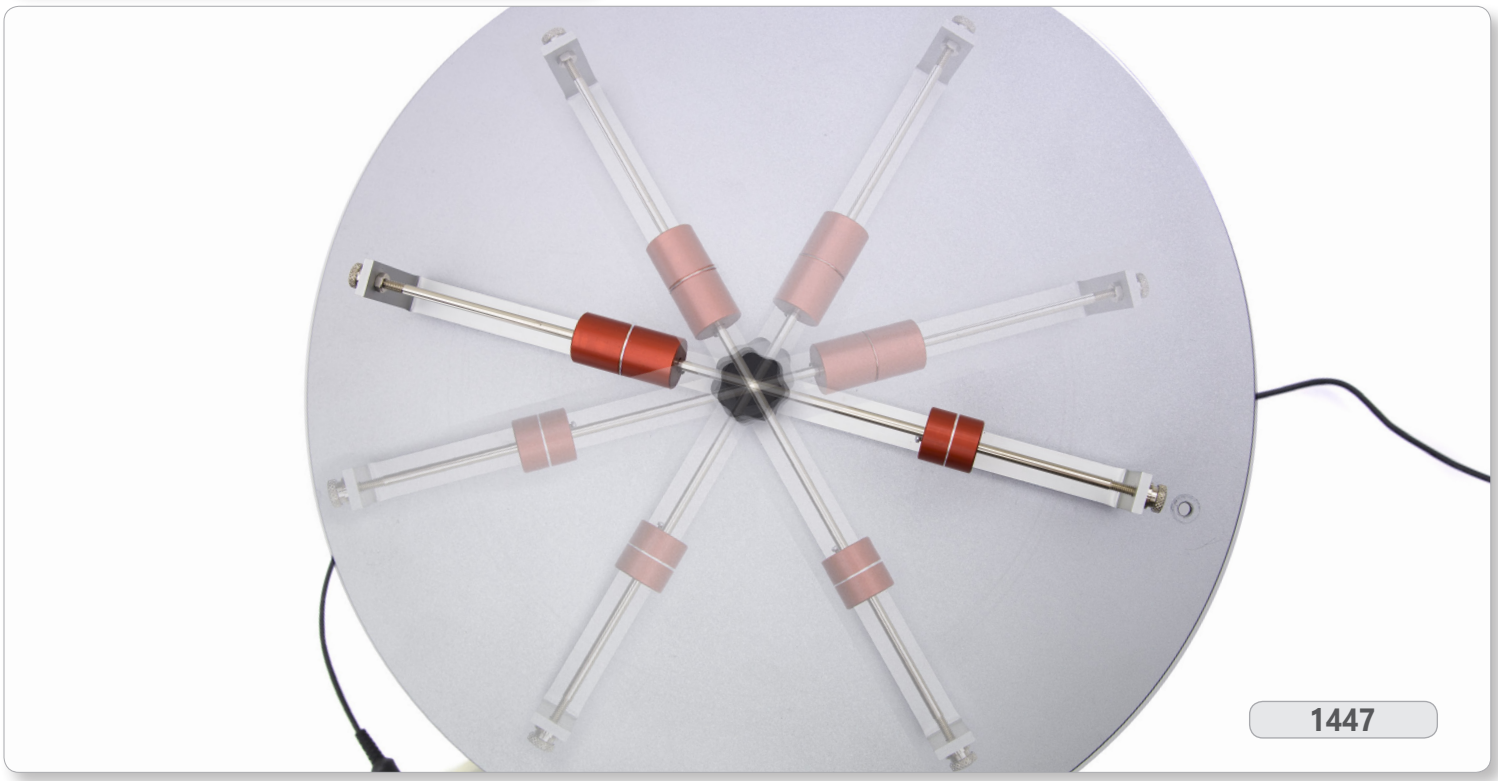
This apparatus is composed of two bodies: the first body has a mass that is double with respect to the second one.
After having switched on the rotating platform, if the two-bodies system remains in equilibrium during the rotation, it means that the two centrifugal forces, which have opposite directions, have equal modules.

Some food for thought: which is the equation that sets the equilibrium conditions of this system?







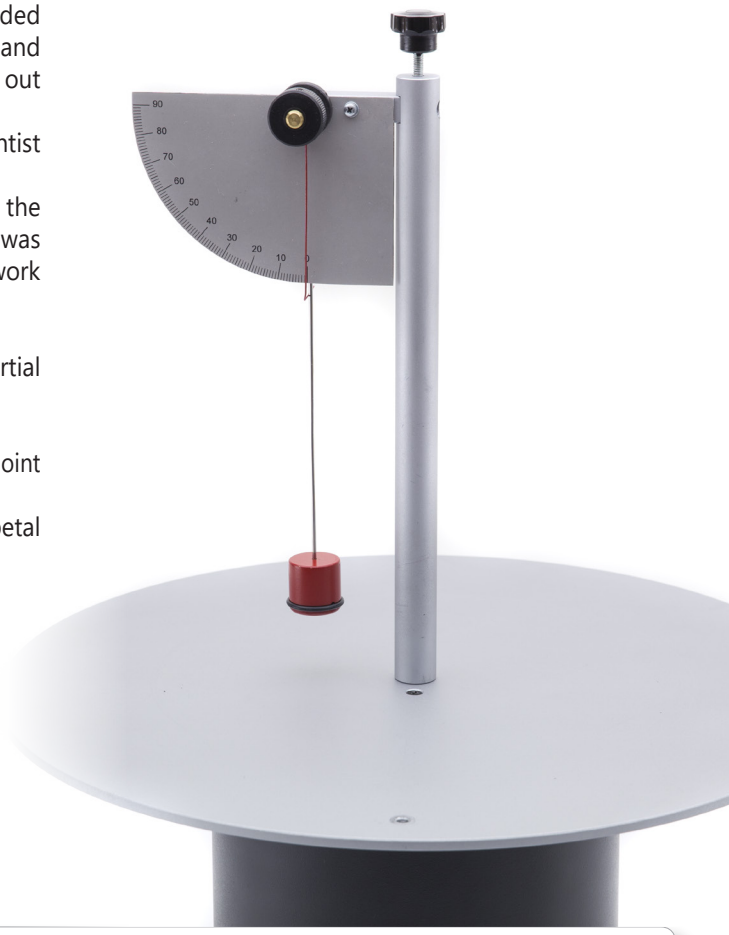


1450 Conical pendulum

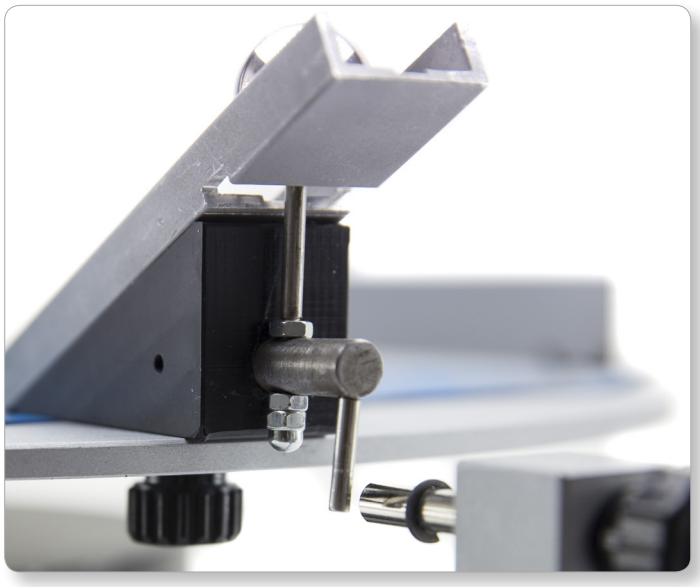
A conical pendulum is composed of a weight fixed on the end of string suspended from a pivot. It is similar to an ordinary pendulum: instead of hanging back and forth, the weight moves at a constant speed in a circle with the string tracing out a cone.
The conical pendulum was studied, for the first time, by the English scientist Robert Hooke around 1660 as a model for the orbital motion of planets.
In 1673, the Dutch scientist Christiaan Huygens calculated its period, using the concept of centrifugal force in his book Horologium Oscillatorium. Later it was used as the timekeeping element in a few mechanical clocks and other clockwork timing devices.

Taking in account the free body diagrams on the inertial and non-inertial reference system; knowing:
- The angular velocity
- The distance between the center of gravity of the pendulum from the hanging point
- The distance of the hanging point from the rotation axis

Thanks to a bit of trigonometry, students will able to calculate the centripetal acceleration.



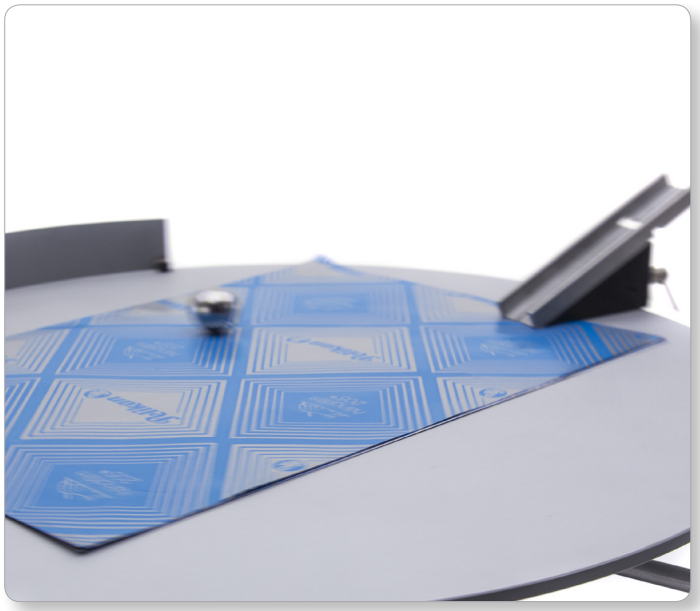
Coriolis effects
1451 Apparatus for Coriolis force



An observer on a non-inertial reference system, that is rotating (it has a radial acceleration), see each body as subjected to the apparent force defined centrifugal force.
Experience shows that, in this case, in addition to the centrifugal force, on bodies in motion - if the direction of the body velocity is not parallel to the angular velocity - in a reference system that is rotating, acts another apparent force called Coriolis force from the name of the discoverer, the French scientist Gaspard-Gustave de Coriolis.
The Coriolis effects are due to the Coriolis acceleration.
The relative formula

$\boldsymbol{a}=-2\boldsymbol{\omega}\times\boldsymbol{v}$

where:
v - the velocity of the body in motion on the non-inertial system
ω - angular velocity

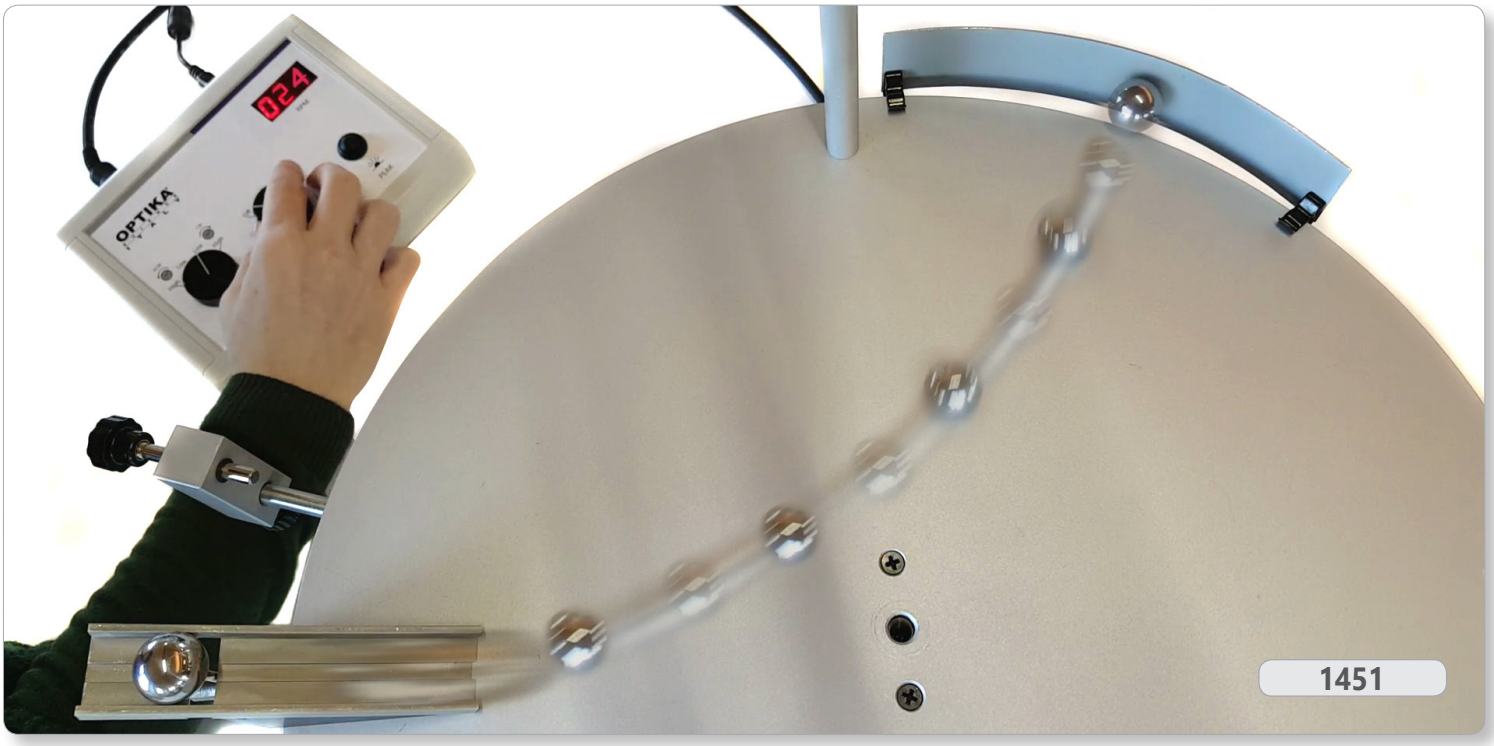


It implies that the Coriolis acceleration is perpendicular both to the direction of the velocity of the moving mass and to the rotation axis of the reference system.

Thanks to this apparatus for Coriolis force (code 1451), students are able to perform the experiment not only in qualitative way but also in quantitative one. From the sphere's trajectory, printed using carbon paper, it's possible to verify Coriolis formula, thanks to graphic method.

Observer O on inertial system: you are the observer.
During the platform rotation, the observer O sees that the sphere keeps its initial radial direction.

Observer O' on rotating reference system: see the video on the smartphone.
An observer O', on the rotating reference system, sees the sphere deviates from its starting trajectory so he must state that, on the sphere, must act an apparent force perpendicular to the axis of rotation, which is the Coriolis force.

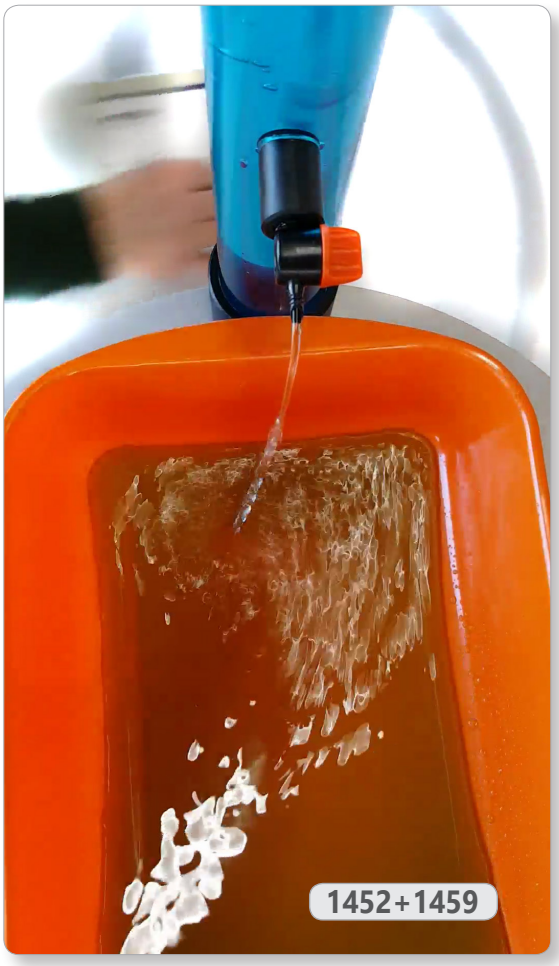


Coriolis effects
1452 Apparatus for water jet

What occurs if, instead of a solid body, we analyze a liquid?
Will Coriolis force produce the same effects?

Observer O on inertial reference system: you are the observer.
During the platform rotation, the observer O sees that the jet of water keeps its initial direction. This occurs because only the hydrostatic pressure acts on the water molecules.

Observer O' on rotating reference system: see the video on the smartphone.
An observer O', on the rotating reference system, sees the water jet deviates, so he must state that, on the water molecules, must act an apparent force perpendicular to the axis of rotation, which is the Coriolis force.



Coriolis effects
1458 Apparatus for falling water

Call to mind the Coriolis acceleration formula:
$\boldsymbol{a}=-2\boldsymbol{\omega}\times\boldsymbol{v}$

What will happen if we use this apparatus for falling water?
After having switched on the rotating platform, students will notice that the drop point has remained almost unchanged, confirming that the Coriolis force is zero since the vectors v and ω are parallel.
Small variations are due to air action.

All these three experiences are fundamental to highlight the need to introduce a powerful and, at the same time, hard mathematical instrument such as the cross product.

Accessories for "Electrical rotating platform"

1445 *Apparatus for centrifugal force*
1447 *Coaxial cylinders*
1082 *Apparatus with inclined test tubes*
1083 *Centrifuge*
1094 *Apparatus with elastic rings*
1093 *Watt's regulator*
1097 *Newton's Disk*
1459 *Bowl with dye (to be used with 1452 and 1458)*
1450 *Conical pendulum*
1451 *Apparatus for Coriolis force*
1452 *Apparatus for water jet*
1453 *Simple pendulum*
1455 *Camera kit (to be used with 1453)*
1458 *Apparatus for falling water*
1460 *Smartphone*

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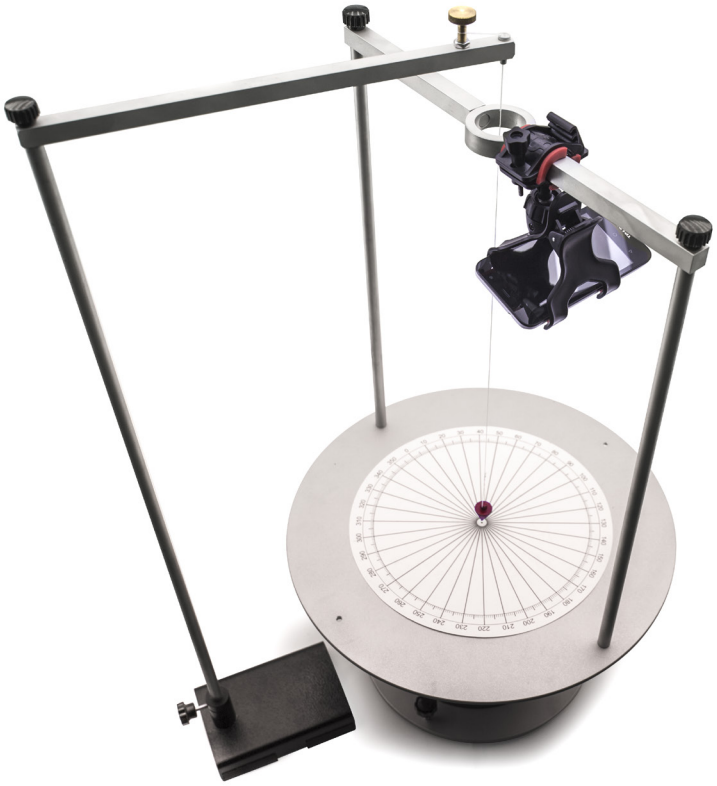
1451

1453 + 1455 + 1460



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