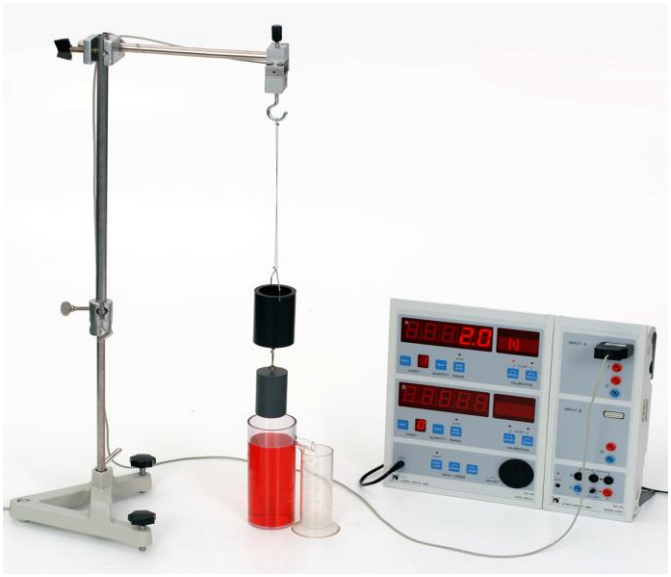
Archimedes' principle - Measurement with Sensor-CASSY and CASSY-Display

Object of the experiment

1. Investigating the relation between the buoyancy force acting on a body and the gravitational force of the liquid displaced by the body

Setup



Stand setup:
- Slide the 40 cm long stand tube over the other one by about 10 cm, and connect the tubes using the universal bosshead.
- Clamp the stand tube with the smaller diameter in the stand base.
- Fasten the Leybold-multiclamp to the other stand tube.

The height of the stand setup can now be adjusted continuously by carefully loosening the lower screw of the universal bosshead.

Preparing the overflow vessel:
- Fill the overflow vessel with water until the water just runs out of the outlet into the measuring cylinder.
- Empty the measuring cylinder, and put it back under the overflow vessel.

Preparing the Archimedes' cylinder:
- Attach the solid cylinder, which fits into the hollow cylinder, to the bottom side of the hollow cylinder by means of a thread.

Preparing the force measurement:
- Put the CASSY-Display into operation with the Sensor-CASSY being connected.
- Connect the force sensor to Input A.
- Switch the display of Input B off with the key NEXT (CASSY) at the display.
- Make the zero adjustment for the unloaded force sensor by pressing the key OFFSET (CALIBRATION) until the red LED blinks.
- After the zero has been adjusted, confirm by pressing the key OFFSET (CALIBRATION) once more.

Apparatus

1 Archimedes' cylinder	362 02
1 Overflow vessel	362 04
1 Measuring cylinder, 100 ml	590 08
1 Sodium chloride, 1 kg	673 5720
1 Methylated spirits, 1 l	670 9990
1 Plastic beaker	590 06
1 Force sensor S, ±50 N	524 042
1 Sensor-CASSY 2	524 013
1 CASSY-Display USB	524 020USB
1 Stand base, V-shape, small	300 02
1 Stand tube, 450 mm, 10 mm diam., set of 2	666 609ET2
1 Stand tube, 400 mm, 13 mm diam.	666 607
1 Stand rod, 25 cm, 12 mm diam.	300 41
1 Universal bosshead	666 615
1 Leybold-multiclamp	301 01
1 Fishing line, set of 2	309 48ET2
1 Glass stirring rod, 300 mm x 8 mm diam.	665 213

Carrying out the experiment

- Suspend the hollow and the solid cylinder from the force sensor as shown in the picture, and determine the gravitational force G_0 .
- Loosen the lower screw of the universal bosshead, and shift the force sensor downwards until the solid cylinder is completely immersed in the water.
- Read the gravitational force G_1 which is now acting from the display, and wait until the water displaced by the solid cylinder has completely run from the overflow vessel into the measuring cylinder.
- The solid cylinder still being immersed, pour the displaced water from the measuring cylinder into the hollow cylinder.
- Read the gravitational force G_2 which is now acting from the display.
- Repeat the measurement with salt water and methylated sprit.

Measuring example

For water:

Gravitational force G_0 in N ((hollow and solid cylinder in air)	2.0
Gravitational force G_1 in N (solid cylinder immersed in water)	1.3
Gravitational force G_2 in N (solid cylinder immersed in water and hollow cylinder filled with displaced water)	2.0

Evaluation

If the solid cylinder is immersed in a liquid, a buoyancy force F_b acts on it in the opposite direction of its gravitational force.
Thereby the gravitational force of the hollow and the solid cylinder is reduced from G_0 to G_1: $G_1 = G_0 - F_b$.

If the water displaced by the solid cylinder is poured into the hollow cylinder, the gravitational force of the hollow and the solid cylinder is again equal to G_0 . Thus the magnitude of the buoyancy force F_b acting on the solid cylinder corresponds to the gravitational force G_W of the water displaced by the solid cylinder: $F_b = G_W$.

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