Friction between two surfaces occurs through a force, the force of friction. It opposes the direction of movement and slows down the motion.

There are different types of friction: Static (adhesive) friction, kinetic (sliding) friction and rolling resistance force. The amount of friction depends on the type of surface.

## Material

5	Support rod stainless steel, I = 150 mm	02030.15
1	Friction block, large	02240.02
1	Spring balance 2.5 N	03060.02
1	Spring balance 0.1 N	03061.01

# Setup and implementation

**Experiment 1** 

- Setup the experiment according to Fig. 1
- Place the friction block with the rubber surface facing down on the table
- Adjust the spring balance 2.5 N in horizontal position to zero
- Hang the spring balance onto the friction block
- Exert horizontal force onto the block and slowly increase until it begins to slide
- Determine the force of friction  $F_{\rm S}$  in which the block remains in a resting position (Table 1)
- Measure the force  $F_{K}$  needed to slide the body
- Place the block with the wooden part facing down on the table, repeat the experiment

Experiment 2

- Place the support rods at a distance of 6-7 cm from each other onto the table (Fig. 2)
- Place the block on the rollers and attach the spring balance (to) 0.1 N
- Determine the force  $F_{Ro}$  that is exerted when gliding the block on the rollers (Table 1)

### **Observation and measurement results**

If a horizontal force is exerted on the wooden block, then at first it remains at rest and does not move position. Only after a certain value does the body begin to suddenly slide. In order to keep the block sliding, a smaller force than before is necessary.

The body slides easily on rollers. Only a very small force is needed.

The rubber and also the wooden surface on the block have the same results. The forces on the rubber surface are however greater than on the wooden surface.



	Table 1		
Force of friction Surface	$\frac{F_{\rm s}}{\rm N}$	$\frac{F_{\rm K}}{\rm N}$	$\frac{F_{Ro}}{N}$
Rubber	1.9	1.3	0.05
Wood	1.1	0.8	0.01

### Evaluation

If a body is to be moved then a force must be exerted in order to overcome the friction. The force of friction keeps the body on the pad and pushes in the opposite direction of the applied force.

There are different types of forces of friction:

- The maximum force that keeps the body on the pad, before it begins to slide is the static friction force  $F_{s}$ .
- The force that is needed to allow the body to slide is called the kinetic friction force  $F_{\rm K}$ .

To roll over the rods the rolling resistance force  $F_{Ro}$  is required.

The experiment shows that a body on rollers is the easiest to move. Rule of thumb:

static friction > kinetic friction > rolling resistance.

The friction also depends on the surfaces of the friction body and the pad. The wooden surface shows on the table less friction than the rubber surface.

The friction occurs through uneven surfaces. The uneven surfaces lock together, thus impeding the motion. During rolling resistance the uneven surfaces roll off of each other.

### Remarks

- 1. Depending on the surface of the table the values for the forces of friction can deviate from those indicated.
- 2. Friction should be minimized in many cases, since it converts valuable energy into unusable heat. For example: Air resistance of vehicles, friction between the wheel and axis.
- 3. In other cases, friction is very useful, for example, for brakes on a car, with icy roads and with knots.