Different objects fall in air-filled space at different speeds. In vacuums, however, they fall at the same speed. This is called “free fall”.

Material

1	Free-fall tube	02500.00
1	Rubber tubing, vacuum, i.d = 6 mm	39286.00
2	Hose clamp for 5-12 mm diameter	40999.00
1	Diaphragm pump, two stage, 220V	08163.93

Setup and implementation

Experiment 1

- Open the cock on the free-fall tube, hold the tube vertically (Fig. 1)
- Turn the tube quickly 180°, observe the feather and the lead pieces

Experiment 2

- Connect the cock of the free-fall tube with the hose on the suction side of the membrane pump, use the hose clamps (Fig.2)
- Pump the air out of the tube, switch off the pump
- Close the cock, release the hose clamp at the cock, carefully pull off the hose
- Hold the tube upright, turn it quickly 180°, observe the feather and the lead pieces

Remarks

The tube is sufficiently evacuated if only a small amount of air continues to seep out on the pressure side of the membrane pump.

Do not carry out this experiment with a water jet pump, since there is a danger that water can enter into the tube.

The vacuum hose should be pulled off carefully and slowly from the free-fall tube so that the cock is not broken off.

Observation

Experiment 1

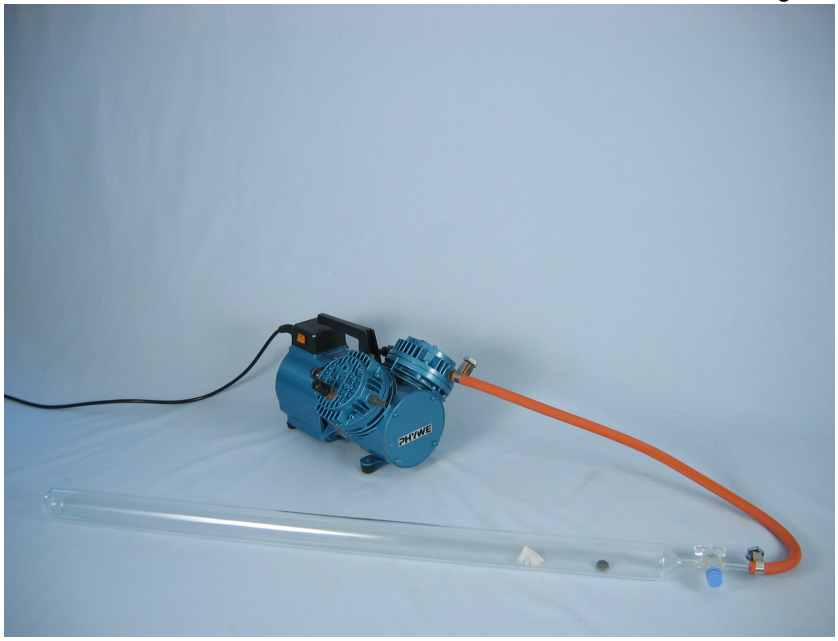
If there is air in the free-fall tube then the feather falls significantly slower than the lead pieces.

Experiment 2

In the air-free tube the feather and the lead pieces fall at the same speed. They reach the bottom at the same time.

Fig.1

Fig.2



Evaluation

Experiment 1

When falling the weight force F_W acts down on both objects and the friction force F_K acts up on both objects. The friction force occurs as a result of the air passing the object as it falls. The larger and more irregular the surface, the greater the air resistance.

A small weight acts down on the light-weight feather, whereas a large friction force exerts upwards. On the metal pieces, a large weight acts down, whereas a small friction force pushes in the opposite direction.

The fall speed of the objects depends on the difference between the frictional force and the weight force. Is this statement really true?

Assumption: The weight force does not play a role. Only the air resistance effects that the feather falls slower than the led pieces. Due to the larger contact surface of the feather a stronger frictional force F_K is exerted than with the smaller lead pieces.

Fig. 3

Experiment 2

In order to check the assumption an influential factor is removed in the second experiment. Here no air resistance exists.

Both objects fall in air-free space at the same speed. This indicates that the different weight force and therefore the different masses have no influence. In the first experiment the different air resistance solely had the effect that the bodies fall at different speeds. The motion does not depend on the mass.

In a vacuum both objects fall at the same speed. They perform uniform accelerated motion.

Remarks

The frictional force of the air depends on the speed. If the height of the fall is too high, the frictional force will be as large as the weight force:

$$F_W = F_K$$

The objects no longer accelerate, but rather carry out a uniform motion (Fig. 4).

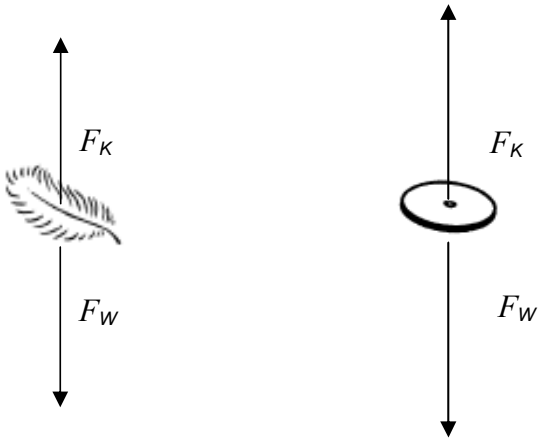


Fig. 4

