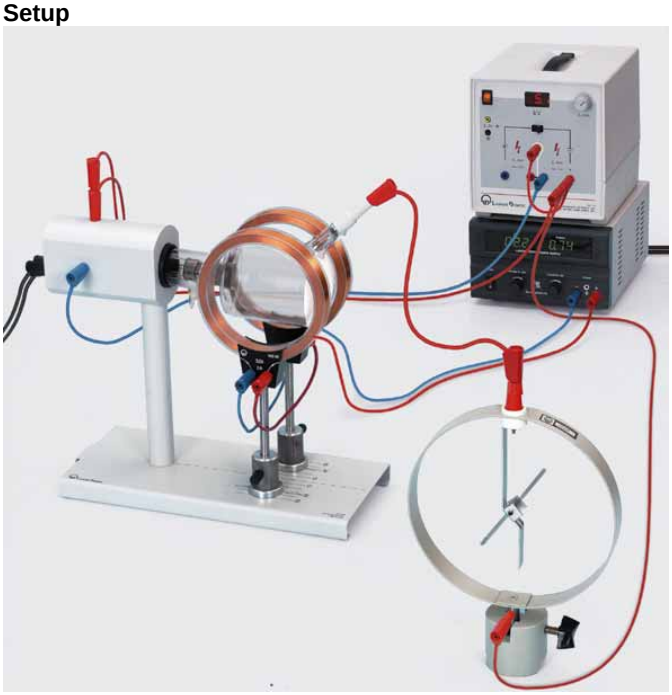
# Thermionic emission
Perrin tube



## Objects of the experiments

1. Demonstrating the emission of charge carriers from the hot cathode of a Perrin tube
2. Proving the negative polarity of the charge carriers

## Setup



Safety note:

When the Perrin tube is operated, hazardous-contact voltages are applied!

The Perrin tube can be damaged by voltages and currents that are too high if it is not connected appropriately (for information on the connection and for technical data see instruction sheet 555 622).

## Apparatus

| | |
|---|---|
| 1 Perrin tube | 555 622 |
| 1 tube stand | 555 600 |
| 1 pair of Helmholtz coils | 555 604 |
| 1 electroscope | 540 091 |
| 1 pair of friction rods, PVC and acrylic | 541 00 |
| 1 cartridge burner DIN type | 666 714 |
| 1 saddle base | 300 11 |
| 1 high-voltage power supply 10 kV, 230 V | 521 70 |
| 1 DC power supply 0-16 v, 5 A | 521 545 |
| 2 safety connecting leads, 100 cm, red | 500 641 |
| 2 safety connecting leads, 100 cm, blue | 500 642 |
| 3 safety connecting leads, 100 cm, black | 500 644 |
| 1 safety connecting lead, 50 cm, red | 500 621 |
| 1 safety connecting lead, 25 cm, red | 500 611 |
| 1 safety connecting lead, 25 cm, blue | 500 612 |

## Carrying out the experiment

Remark:

Before the experiment is carried out, the result of experiment D 3.1.2.1.a (charge separation through contact) should be known.

1. Demonstrating the emission of charge carriers from the hot cathode of a Perrin tube
   - Heat the cathode of the Perrin tube by switching the high-voltage power supply on.
   - Slowly increase the high voltage between the cathode and the anode from 0 kV to 5 kV, continuously observing the screen.
   - Switch the cathode heating off for a short time by unplugging the connecting lead at the connection F1.
   - Observe the screen, and connect the connecting lead again to the connection F1.
   - Switch the low-voltage power supply on, and increase the voltage applied to the Helmholtz coils until the luminous spot visible on the screen disappears in the opening of the attached Faraday's cup. While doing so, observe the electroscope.
   - Switch the low-voltage power supply off.
2. Proving the negative polarity of the charge carriers
   - Discharge the friction rods, and hit them together several times.
   - Rub the electroscope with the acrylic rod (positively charged).
   - Repeatedly hit the rods together, and rub the electroscope with the acrylic rod. Observe what happens with the electroscope.

Repeat the experiment parts 1 and 2, however, rub the electroscope with the PVC rod (negatively charged).

## Observation

After the heating voltage has been switched on, the cathode starts to glow.

If the voltage between the cathode and the anode is increased, a green luminous spot appears on the screen of the Perrin tube.

When the cathode heating is switched off, the luminous spot disappears.

If the voltage applied to the Helmholtz coils is increased, the luminous spot moves upwards and hits the Faraday's cup at a voltage of approx. 2-3 V.

When the luminous spot hits the Faraday's cup, a deflection of the electrometer pointer is observed.

If the voltage applied to the Helmholtz coils is lowered, the luminous spot is visible on the screen again. The deflection of the pointer is retained.

When the electroscope is rubbed with the positively charged acrylic rod, the deflection of the pointer decreases.

When the electroscope is rubbed with the negatively charged PVC rod, the deflection of the pointer increases.

## Evaluation

When the cathode of the Perrin tube is heated, charge carriers are released from its surface.

By applying a voltage between the cathode and the anode, the charge carriers are accelerated and generate a luminous spot when they impinge on the fluorescent screen.

If the charge carriers are conducted into the Faraday's cup, the cup is charged. A deflection of the pointer is clearly seen at the electroscope.

As the electroscope is discharged on contact with a positively charged friction rod, the charge carriers released from the cathode are negatively charged (electrons).

The release of electrons from the surface of glowing metals is called thermionic emission.



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