Experiment no. 5.2.89-00

# Self-maintained discharge of gases in the discharge tube

A high voltage is applied to the electrodes of a Pohl's tube, which results in a current along the tube. While reducing the pressure in the tube a luminescence phenomena (gas discharge) is observable.

## Principle

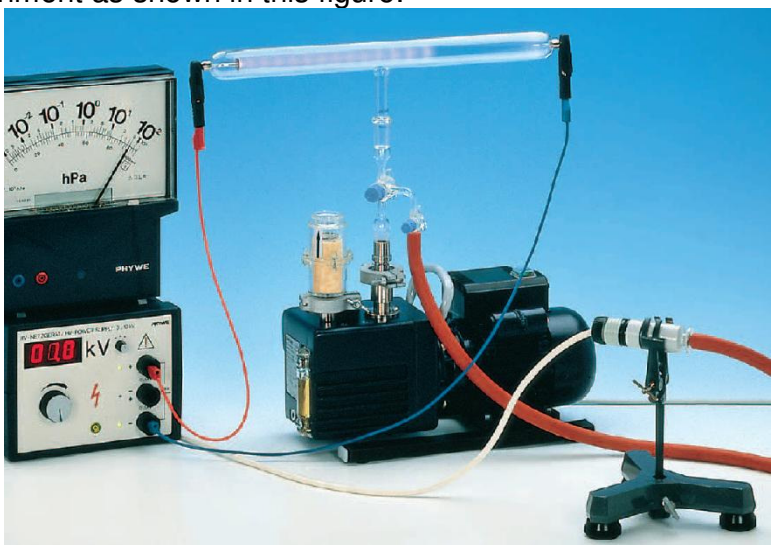
Conductivity of electricity in gases requires the presence of charged particles (ions). In the low pressure of a vessel (approx. 0.03 to 0.001 mbar are sufficient), ions are formed at high voltage. The ions enable the flow of an electrical current, which is called gas discharge. The resulting gas discharge is demonstrated using a Pohl's tube.

## Equipment list

| | | |
|---|---|---|
| 06640-00 | Discharge tube, Pohl type | 1 |
| 06641-00 | Intermed.piece f.discharge tube | 1 |
| 07206-01 | Plug with socket and crosshole, 2 pcs. | 1 |
| 07276-11 | Crocodile clips, red, 10 | 1 |
| 07367-00 | Connecting cord, 30 kV, 1000 mm | 2 |
| 13670-93 | High voltage supply unit,0-10kV | 1 |
| 02002-55 | Tripod base -PASS- | 1 |
| 37715-00 | Universal clamp | 1 |
| 39288-00 | Rubber tubing,vacuum,i.d.8mm | 1 |
| 11112-93 | Range multiplier, vacuum | 1 |
| 11100-00 | Moving coil instrument | 1 |
| 07361-01 | Connecting cord, 500 mm, red | 1 |
| 07361-04 | Connecting cord, 32 A, 500 mm, blue | 1 |
| 07359-04 | Connecting cord, 100 mm, blue | 1 |
| 07360-04 | Connecting cord, 250 mm, blue | 1 |
| 02751-93 | Vacuum pump, two-stage | 1 |

## Experimental arrangement

Set up the experiment as shown in this figure:



## Experimental procedure

Set knob 3 of the high-voltage power into center position. Of the three LEDs, only the top and bottom LEDs must be on, the LED in the middle position must be off. Set a voltage of 7.5 kV and darken the room. Create a vacuum in the discharge tube and observe the tube. Note down the pressures at which the different states of gas discharge arises.
If after approx. 30 seconds there are no changes in the tube anymore, you can stop the experiment.

## Result

At atmospheric pressure no current does flow through the discharge tube. Shortly after beginning of the evacuation flow of current occurs. At the same time inside the discharge tube light activity can be observed. This activity changes continuously as long as the final pressure has not been reached. As soon as it is reached, red light can be observed in the thin air between the anode up to the middle of the tube. The red light is accompanied by weak blue light (fluorescence) of the glass wall.

The physical processes in the discharge tube can be explained as follows: the tube always contains some positive ions that are created for example through cosmic radiation. However, their concentration is not high enough to form a current. By applying a high voltage, the ions are accelerated, i.e. their energy is raised. As soon as the voltage is high enough, the accelerated ions reach an energy level that is sufficient to ionize the molecules near to the cathode surface. The electrons separated from the molecules are accelerated towards the anode. In the region in front of the anode that is alighted red, additional ions are generated by collision between atoms and electrons, which migrate towards the cathode again, etc. This process causes a continuous current increase in case a series resistance does not limit it. In this experiment the current-limiting resistor is already built into the high-voltage power supply.