UE3020100 CHARGED DROPLETS OF WATER

OBJECTIVE

Demonstrate the electric current generated by the motion of charged droplets of water

SUMMARY

Electric current arises due to an amount of charge being transported during a given interval of time. A flow of current can be simply illustrated with the help of charged droplets of water. In order to carry out the measurement, a burette and a Faraday cup connected to an electrometer will be used. The charge accumulated in the Faraday cup in a certain period of time is measured with the help of the voltage which drops across the capacitor. This allows the charge per droplet and the current to be determined.

EXPERIMENT PROCEDURE

- **Measure the charge transferred to a Faraday cup by charged droplets of water dripping from a burette as a function of the time.**
- **Determine the current generated by the movement of the charged water droplets.**
- **Determine the charge on each droplet.**

REQUIRED APPARATUS

Quantity	Description	Number
1	Electrometer (230 V, 50/60 Hz)	**1001025 or**
	Electrometer (115 V, 50/60 Hz)	**1001024**
1	Electrometer Accessories	**1006813**
1	Analogue Multimeter AM50	**1003073**
1	Burette, 10 ml	**1018065**
1	Constantan Wire 0.2 mm / 100 m	**1000955**
1	DC Power Supply 450 V (230 V, 50/60 Hz)	**1008535 or**
	DC Power Supply 450 V (115 V, 50/60 Hz)	**1008534**
1	Digital Multimeter P3340	**1002785**
1	Digital Stopwatch	**1002811**
1	Tripod Stand 150 mm	**1002835**
1	Stainless Steel Rod 1000 mm	**1002936**
2	Universal Clamp	**1002830**
1	Universal Jaw Clamp	**1002833**
1	Crocodile Clip 4 mm, Not Insulated	**1002844**
1	Set of 3 Safety Experiment Leads for Free Fall Apparatus	**1002848**
2	Pair of Safety Experimental Leads, 75cm, red/blue	**1017718**
1	Peleus ball, standard	**1013392**
1	Set of 10 Beakers, Low Form	**1002872**
Additionally recommended:		
1	3B NET*log*™ (230 V, 50/60 Hz)	**1000540 or**
	3B NET*log*™ (115 V, 50/60 Hz)	**1000539**
1	3B NET*lab*™	**1000544**

BASIC PRINCIPLES

Electric current arises due to an amount of charge being transported during a given interval of time. A flow of current can be simply illustrated with the help of charged droplets of water.

In this experiment a number of charged water droplets N drips at a constant rate of roughly one droplet per second from a burette into a Faraday cup connected to an electrometer and a capacitor. The charge Q accumulated in the Faraday cup causes the capacitor to charge up. The resulting voltage across the capacitor is observed and measured using an analogue multimeter for a certain period of time t. The high-resistance input of the operational amplifier in the electrometer ensures that the capacitor does not discharge via that path.

Observation of the analogue multimeter indicates that the voltage across the capacitor increases by about the same amount with every droplet collected in the Faraday cup, i.e. each of the droplets carries approximately the same charge:

(1) $$q = \frac{Q}{N}.$$

The current transported is given by

(2) $$I = \frac{Q}{t}.$$

As an option, the voltage across the capacitor can be recorded with the help of 3B NET*log*™ and 3B NET*lab*™ as a function of time t and displayed in the form of a graph.

EVALUATION

The charge Q accumulated in the Faraday cup is determined by reading of the voltage U and calculating Q from that:

$Q = C \cdot U$ where $C = 1$ nF: capacitance of capacitor

Using 3B NET*log*™ and 3B NET*lab*™ the time characteristic $Q(t)$ can be measured. It is step-shaped whereby the individual steps mark the charge q that accumulates with each individual droplet per time interval Δt. The fact that each water droplet carries almost the same charge is reflected in the constant step height of the characteristic.

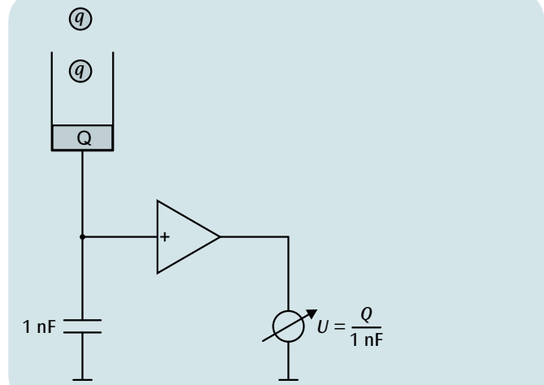

Fig. 1: Schematic illustrating the principle behind the measurement

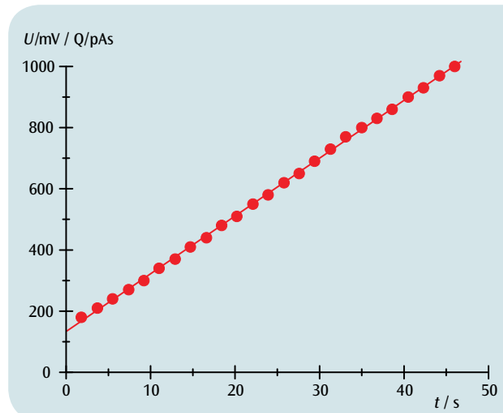

Fig. 2: Accumulated charge Q as a function of time t