Investigating the Hall effect in silver (P 7.2.1.1)(a)

P 7.2.1

Hall effect

P 7.2.1.1 Investigating the Hall effect in silver

P 7.2.1.2 Investigating the anomalous Hall effect in tungsten

P 7.2.1.3 CASSY-S Determining the density and mobility of charge carriers in n-germanium

P 7.2.1.4 CASSY-S Determining the density and mobility of charge carriers in p-germanium

P 7.2.1.5 CASSY-S Determining the band gap of germanium

Cat. No.	Description	P 7.2.1.1(a)	P 7.2.1.1(b)	P 7.2.1.2(a)	P 7.2.1.2(b)	P 7.2.1.3	P 7.2.1.4	P 7.2.1.5
586 81	Hall effect apparatus, silver	1	1					
586 84	Hall effect apparatus, tungsten			1	1			
586 850	Base unit for Hall effect (Ge)					1	1	1
586 853	n-Ge on plug-in board					1		
586 852	p-Ge on plug-in board						1	
586 851	Ge undoped on plug-in board							1
532 13	Microvoltmeter	1		1				
531 835	Universal Measuring Instrument Physics	1		1				
524 009	Mobile-CASSY		2		2			
524 040	µV-box		1		1			
524 010USB	Sensor CASSY					1	1	1
524 200	CASSY Lab					1	1	1
524 0381	Combi B-sensor S	1	1	1	1	1	1	
501 11	Extension cable, 15-pole	1	1	1	1	1	1	
521 55	High current power supply	1	1	1	1			
521 39	Variable extra low voltage transformer	1	1	1	1			
521 501	AC/DC power supply 0....15 V					2	2	1
521 545	DC power supply 0....16 V, 5 A					1	1	1
562 11	U-core with yoke	1	1	1	1	1	1	
560 31	Pair of bored pole pieces	1	1	1	1	1	1	
562 13	Coil with 250 turns	2	2	2	2	2	2	
531 130	Multimeter LD analog 30	1	1	1	1			
300 41	Stand rod, 25 cm	1	1	1	1	1	1	
301 01	Leybold multiclamp	1	1	1	1	1	1	
300 02	Stand base, V-shape, 20 cm	1	1	1	1	1	1	1
501 46	Pair of cables, 1 m, red and blue	4	4	4	4	7	7	4
501 33	Connecting lead, Ø 2.5 mm2, 100 cm, black	2	2	2	2			
	additionally required: PC with Windows 95/98/NT or higher					1	1	1

In the case of electrical conductors or semiconductors within a magnetic field B, through which a current I is flowing perpendicular to the magnetic field, the Hall effect results in an electric potential difference

$$U_H = R_H \cdot B \cdot I \cdot \frac{1}{d}$$

d: thickness of sample

The Hall coefficient

$$R_H = \frac{1}{e} \cdot \frac{p \cdot \mu_p^2 - n \cdot \mu_n^2}{(p \cdot \mu_p + n \cdot \mu_n)^2}$$

e: elementary charge

depends on the concentrations n and p of the electrons and holes as well as their mobilities μ_n and μ_p, and is thus a quantity which depends on the material and the temperature.

The first two experiments determine the Hall coefficient R_H of two electrical conductors by measuring the Hall voltage U_H for various currents I as a function of the magnetic field B. A negative value is obtained for the Hall coefficient of silver, which indicates that the charge is being transported by electrons. A positive value is found as the Hall coefficient of tungsten. Consequently, the holes are mainly responsible for conduction in this metal.

The third and fourth experiments explore the temperature-dependency of the Hall voltage and the electrical conductivity

$$\sigma = e \cdot (p \cdot \mu_p + n \cdot \mu_n)$$

using doped germanium samples. The concentrations of the charge carriers and their mobilities are determined under the assuption that, depending on the doping, one of the concentrations n or p can be ignored. In the final experiment, the electrical conductivity of undoped germanium is measured as a function of the temperature to provide a comparison. The measurement data permits determination of the band gap between the valence band and the conduction band in germanium.