Planck's "quantum of action"

5.2.8

Related concepts

Continuous (retarded) radiation, characteristic radiation, crystal plane, lattice spacing, minimum wavelength, limiting frequency.

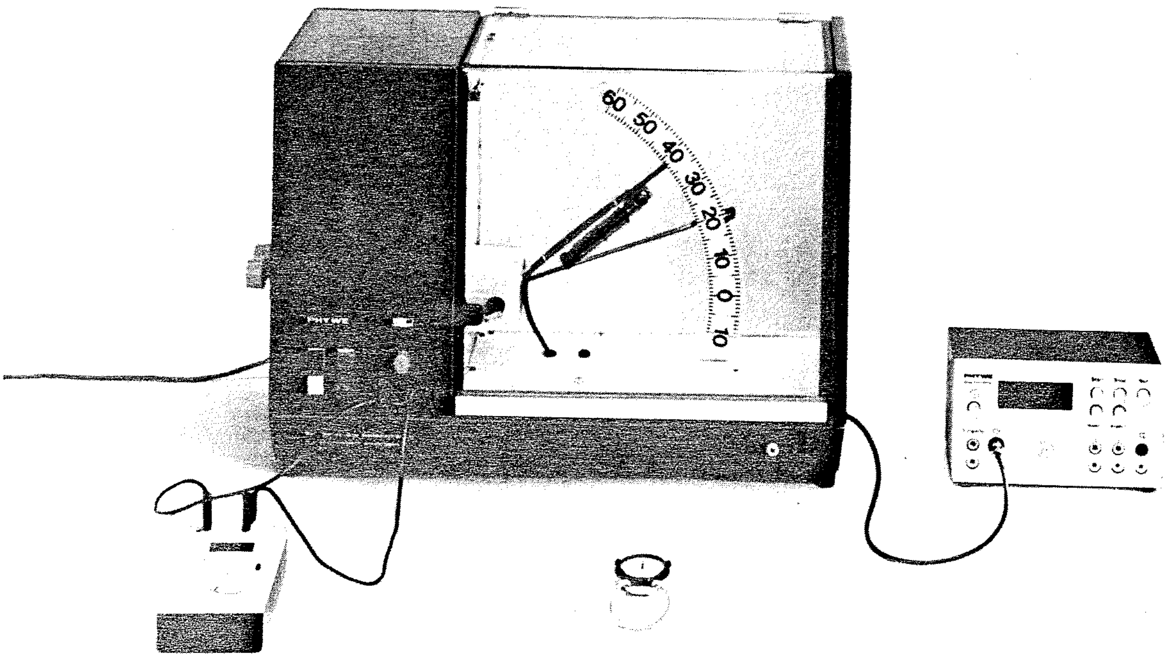
Principle

The intensity of X-rays of different frequencies is measured as a function of the anode voltage. From the limiting voltage thus determined, Planck's constant is determined as a function of the frequency.

STOP WATCH, INTERRUPTION TYPE	03076.01	1
DIGITAL HAND MULTIMETER 2A,LCD	07132.00	1
CONNECTING CORD, 500 MM, RED	07361.01	1
CONNECTING CORD, 500 MM, BLUE	07361.04	1
COUNTER TUBE, TYPE A, BNC	09025.11	1
X-RAY UNIT, 220 V AC	09052.93*	1
COUNTER/TIMER,4D.,LOUDS.,5V OUT	11758.93*	1
FLAT CELL BATTERY, 9 V	07496.10	1

The equipment marked * is designed for connection to 220 V a.c., 50 Hz mains. It can also be supplied for other mains voltages or frequencies.

Fig. 1: Experimental set up for determining the intensity of X-radiation as a function of the anode voltage.



where d is the distance between the lattice planes. At each position of the scattering crystal a certain wavelength is filtered out of the white radiation. The crystal used is LiF with a lattice spacing of

$$d = 2.01 \cdot 10^{-10} \text{ m} .$$

Thus, a corresponding wavelength or frequency can be allocated to each angular position of the crystal.

The intensity of different wavelengths is measured as a function of the anode voltage.

By extrapolating the curves in Fig. 3 the limiting voltage U_o is determined as a function of the frequency.

Fig. 3: Intensity of X-radiation of different wavelengths as a function of the anode voltage.

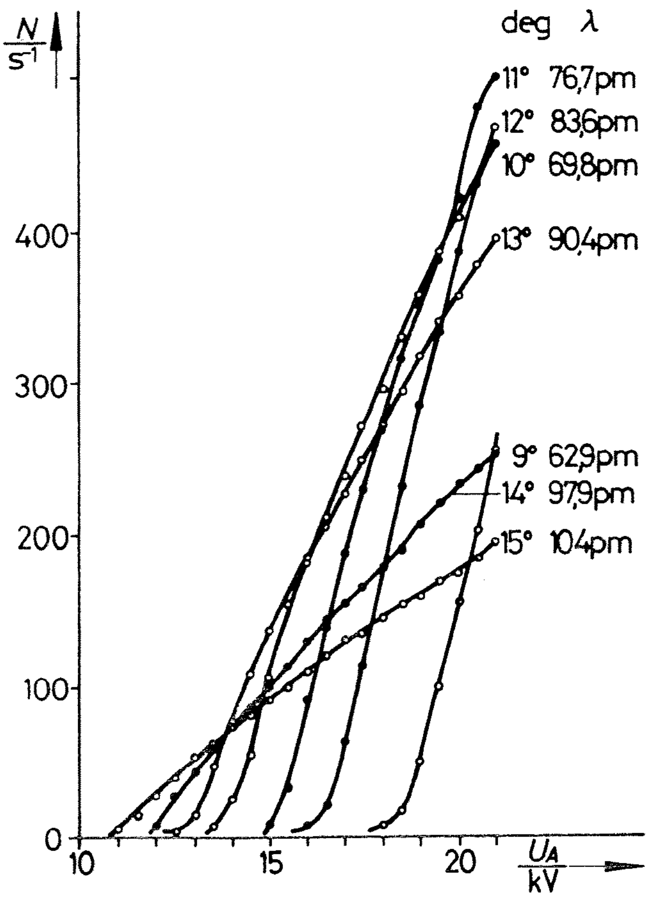
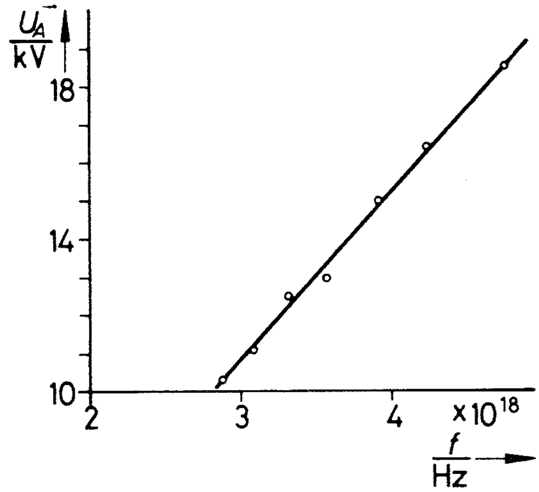


Fig. 4: Limiting voltage U_o as a function of the frequency.



From the regression lines to the values plotted in Fig. 4, using the linear equation:

$$Y = A + BX,$$

we obtain the gradient

$$B = 4.12 \cdot 10^{-15} \frac{\text{J}}{\text{A}} \qquad \text{(see (1))}$$

with the standard error:

$$SD\ B = 0.07 \frac{\text{J}}{\text{A}} .$$

From this, using the electron charge

$$e = 1.60 \cdot 10^{-19} \text{ As},$$

we obtain Planck's constant

$$h = 6.61 \cdot 10^{-34} \text{ Js}.$$