Radioactivity of Potassium

Besides Uranium and Thorium, Potassium is also a natural radioactive substance. With 2.6 weight percentage, it belongs to the 10 most frequent elements in the earth's crust and is present in a number of minerals and also in all organic substances.
Natural potassium is made up of three isotopes, K-39 with a concentration of 93.2581 %, K-41 with 6.7302 % and the radioactive isotope K-40 with a very low concentration of just 0.0117 %.
Because of its high half-life, the specific activity of potassium is very low; hence, one can experiment with any quantity of potassium without any risk.
Because of its high natural occurrence, potassium contributes about 12% to the total radiation exposure of the human body. Even the human body contains 15 g of potassium on an average. This produces a radioactivity of 3 to 5 kBq.
In potassium mines the mined stones are checked radiometrically for their potassium content, whereby the salts can appear in solid form as well as in liquid solutions. There exists a proportionality between the potassium content and impulse rate. This method is demonstrated in the classroom, when for example, potassium salt is mixed with common salt in different quantities and the impulse rates are compared.
While studying the different types of salts, the potassium salt can then be detected as the single "radioactive salt".

Equipment

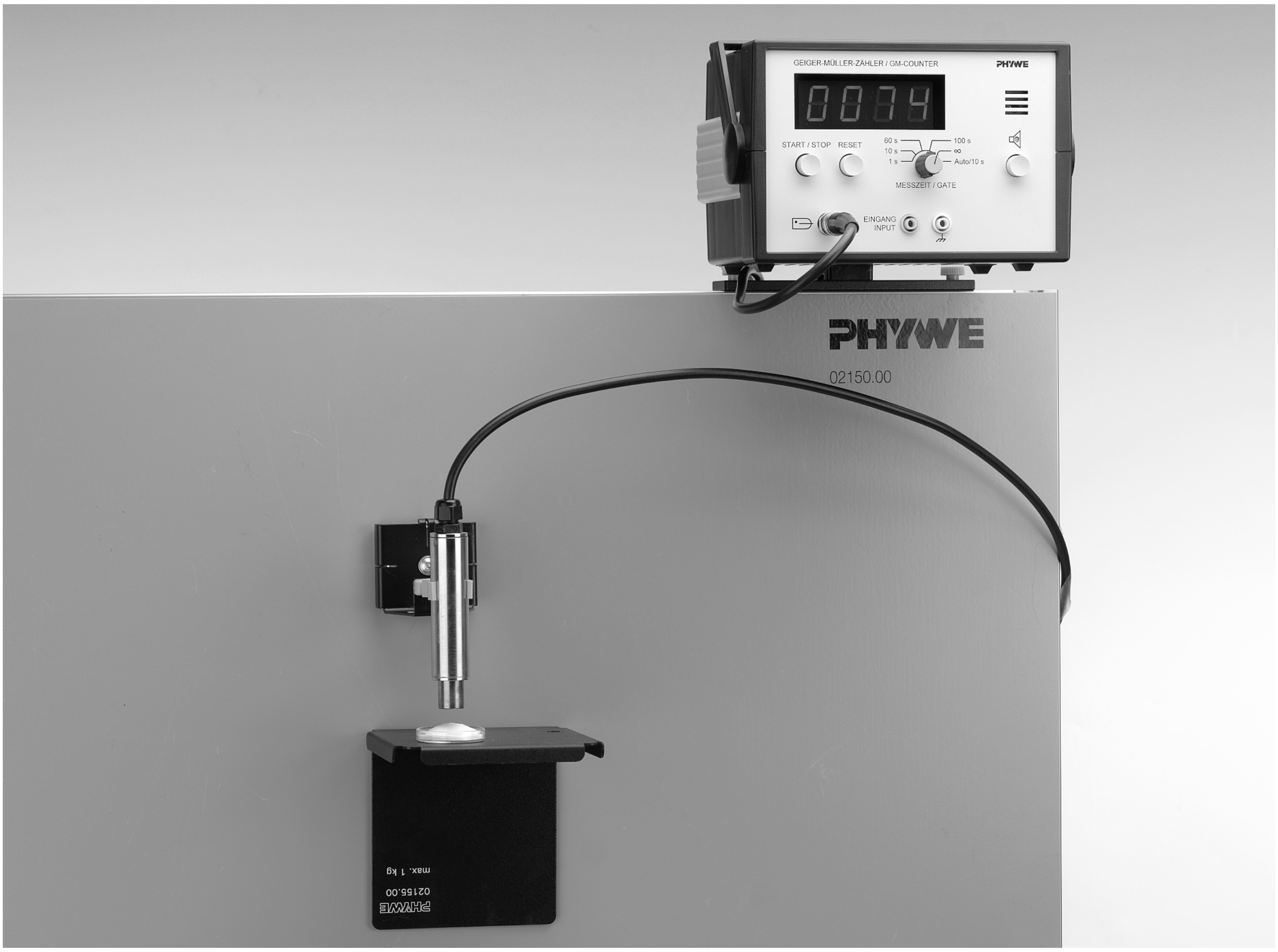
Support clamp for small case	02043.10	1
Clamp on holder	02164.00	1
Support rod, stainless steel	02030.00	1
Counter tube holder on fix. magnet	09201.00	1
Support plate on fixing magnet	02155.00	1
Counter tube Type B	09005.00	1
Geiger-Müller-Counter	13606.99	1
Demo-Board for Physics with stand	02150.00	1
Petri-dish, *d* = 40 mm, Glass	64704.00	2
Potassium chloride (K-40)	30098.25	1
Copper-II sulphate	30126.25	1
Sodium chloride (commercially available cooking salt)		

Set-up and procedure

Fig.1

— The experiment is set-up as shown in Fig. 1

Fig. 1: Experimental setup



— Fill the petri dishes with the different salt types and paste a label with name on each for identification.
— Fix the counter tube vertically in its holder and remove its protective cap.
— Select a measurement time of 100 s at the counter and determine the zero rate at least three times; Enter the values in Table 1.
— Place the first petri dish on the support plate and move the counter tube carefully near it upto a distance of 1 cm; determine the impulse rate at least three times and enter the values in Table 1.
— Each time before changing the petri dish move the counter tube to a safe distance and then restore the original distance after changing the dish.
— Determine the impulse rate at least three times for each salt sample.
— After concluding the measurements, replace the protective cap of the counter tube.

Result
See Table 1

Evaluation
Excepting the potassium salt, the mean values of the impulse rates of all the salts lie within the statistical inaccuracy of the mean value of the zero rate.
A little radioactivity can be seen in the case of potassium salt. The mean value of the registered impulse rate is 43 Imp/100 s, after subtracting the mean value of the zero rate, which shows that potassium is a weak radioactive substance.
Note: Potassium-40 decays with a radioactive half-life of $1.27 \cdot 10^9$ years with a probability of 89.3% through β-decay and with a probability of 10.7% through K-capture and emission of γ-radiation.

Table 1

Running No.	$\frac{Z_0}{\text{Imp/100s}}$	Sodiumchloride $\frac{Z}{\text{Imp/100s}}$	Coppersulphate $\frac{Z}{\text{Imp/100s}}$	Potassiumchloride $\frac{Z}{\text{Imp/100s}}$
1	29	32	33	71
2	33	30	31	68
3	28	31	27	79
$\overline{Z}$	30	31	30	73