The concentration of two other vitamins for which microbiological assays were not available, thiamin and pyridoxine, were so low as to be negative toward colour tests, even though the material was first concentrated to some extent by adsorption and elution.

It is evident that the juice was not of high nutritive quality. The minimum daily requirement of riboflavin, for example, according to the Food and Nutrition Board of the U.S. National Research Council, for a 'very active' individual of 70 kilos is 3·3 mgm. per day. To meet this requirement, the daily consumption of coco-nut juice would have to be at least 330 litres.

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[1] *Nature*, **155**, 392 (1945).

Spectral Analysis of Solid Substances

A METHOD has been developed whereby it is possible to deduce from a single spectral photograph not only the qualitative analysis of a totally unknown mineral powder, but also its *approximate* quantitative composition.

For this purpose mixtures have been made of all spectrographically detectable elements at our disposal; the concentrations were 10, 3, 1, 0·3, 0·1 down to 0·0001 per cent. Pure, washed quartz-sand was used as a basis for the various dilutions.

In order to reduce the amount of work and time required for the preparation of the standard spectrograms, the elements which had to be considered were divided into groups of ten, the sensitive lines of which do not coincide. Quantities of the pure chemical compounds, equivalent to 100 mgm. of the oxides, of all elements of the same group were thoroughly mixed in an agate mortar under alcohol. One tenth of this mixture was added to 900 mgm. of the pure quartz powder, thus obtaining a mixture containing 1 per cent of each of the oxides concerned.

The lower concentration steps have been obtained by diluting this 1 per cent mixture with a calculated amount of pure silica. The higher concentration steps have been prepared as follows: (*a*) for the 10 per cent mixture: 100 mgm. of the oxide of each element were mixed with 900 mgm. of pure silica; (*b*) for the 3 per cent mixture: 300 mgm. of the 10 per cent mixtures of each member of a subgroup of three elements of the same group were ground with 100 mgm. of the pure quartz sand.

Before taking the spectrogram, each mixture was mixed again with half its weight of sodium carbonate.

The photographs were taken with the continuously burning electric arc between very pure, plane carbon electrodes of 5 mm. diameter. The arc burns for 60 sec. at 4 amp., and then for 30 sec. at 7 amp. We used a Hilger E.315 quartz spectrograph. A diffusely and uniformly illuminated slit is obtained by focusing the arc sharply on a screen in which is inserted a rectangular diaphragm; the illuminated opening of this screen is focused enlarged on the collimator lens of the spectrograph.

A rotating step sector (factor $r = 3·5$) was placed before the slit of the spectrograph. The intensity of the lines chosen for analysis is compared for each concentration with the intensity of certain Si-lines from the spectrum (the concentration of silica being approximately constant). This comparison is performed visually, under a twenty-fold enlargement, with a Zeiss spectral projector. The relative intensity (rather the relative exposure) is denoted by the difference in the number of 'steps' to be applied to the two lines under comparison in order that they may show equal blackening[1].

For the lowest concentrations a spectrum is taken with illumination forming an image of the arc on the slit, without a step sector, the cathode layer effect being used. Again the intensities of the weak lines are compared with those of the Si-lines of the stepped spectrum.

Tables have been drawn up, giving the relative intensities as a function of concentration, for the most prominent lines of fifty-six different elements.

A number of synthetic mixtures have been prepared, and then analysed by means of the method described, with the aid of the data of our tables. Some results are given in the accompanying table, which includes also the results for a natural mineral (tourmaline).

It will be seen that a fair estimate of the concentration of the elements present is obtained.

I			II			III (tourmaline)		
	Calculated	Found		Calculated	Found		Chemical analysis	Spectral analysis
CaO	5	3–4	CaO	0·16	0·12	CaO	1·35	1·30
MgO	0·1	0·15	MgO	0·8	0·7	K_2O	2·07	2–3
MnO	0·41	0·40	MnO	0·2	0·35	Na_2O	2·25	
Fe_2O_3	0·2	0·3	Fe_2O_3	1·0	1·0	Fe_2O_3	12·35	14·2
Al_2O_3	0·04	< 0·4	Al_2O_3	2·5	1·7	Al_2O_3	24·67	30·0
TiO_2	0·1	0·14	TiO_2	0·04	0·05	MgO	7·32	6·3
ZrO_2	0·04	< 0·1	B_2O_3	0·8	0·5	MnO	0·27	0·25
V_2O_5	0·012	0·02	K_2O	0·4	0·3	TiO_2	0·34	0·39
Cr_2O_3	0·012	0·01				B_2O_3	6·89	5·5
						CuO	< 0·05	0·03
						(SiO_2	37·5	18·6)

The complete account of this work has been communicated to the Koninklijke Vlaamsche Academie v. Wetenschappen, Letteren en Schoone Kunsten v. Belgie, and will be published in the *Verhandelingen* from this Society.

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[1] See Breckpot, R., *Spectrochim. Acta*, **1**, 2 (1939).

A Tetrabromide of β-Phellandrene

IT has been generally accepted that β-phellandrene does not form a tetrabromide, and indeed we have found no reference in the literature to the formation of such a compound by a conjugated terpene apart from a recent record of a liquid tetrabromide derived from α-terpinene[1]. During examination of the terpene fractions of the oil from *Eucalyptus cneorifolia*, we repeatedly isolated a crystalline tetrabromide which had m.p. 110–112° and was *dextro*-rotatory. After recrystallization from ethyl acetate, the melting point rose to 118–119°, the specific rotation being almost + 54°.

Microanalysis established the formula of the substance as $C_{10}H_{16}Br_4$, and the hydrocarbon recovered on treatment with magnesium and ether[2] showed the

characteristic features of *l*-β-phellandrene, forming, for example, a nitrosite[3] and a nitrosochloride[4]. That the tetrabromide was derived from this hydrocarbon was supported by the formation of a crystalline derivative from a sample of *l*-β-phellandrene isolated from Canada balsam oil. This had practically identical physical properties, and on admixture with the sample from the eucalyptus oil there was no depression of melting point.

The chief feature of the tetrabromide from β-phellandrene is the change of sign of rotation, the *lævo*-rotatory hydrocarbon giving a *dextro*-rotatory tetrabromide. The investigation was further extended by formation of a crystalline tetrabromide from a sample of *d*-β-phellandrene derived from water fennel oil (*Phellandrium aquaticum* L.)[5]. This also had a melting point of 118–119° and had a specific rotation of − 53°.

A detailed account of the work will be published elsewhere.

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[1] Ipatieff and Pines, *J. Amer. Chem. Soc.*, **66**, 1120 (1944).
[2] von Braun and Lemke, *Berichte*, **56**, 1562 (1933).
[3] Macbeth, Smith and West, *J. Chem. Soc.*, 119 (1938).
[4] West, *J. Soc. Chem. Ind.*, **58**, 122 (1939).
[5] Berry, Macbeth and Swanson, *J. Chem. Soc.*, 1448 (1937).

Symbols Used to Indicate Hydrogen Ion Concentration and Similar Quantities

The symbols *pH* and *pK*, commonly encountered in chemical literature, each consist of two letters, the second of which may, or may not, be used as a subscript, and either or both of which may be set alternatively in roman type or in italics. There appears to be no generally accepted convention governing the choice from the many resulting possible forms, and inconsistencies are often encountered even within a single published article.

According to its origin, the letter '*p*' in the symbol *pH* is an operator describing a function of the variable denoted by the letter '*H*'. Presumably in order to show the different significances of the two letters in the compound symbol, it was originally written with a subscript '*H*' by Sörensen. This arrangement, besides being somewhat inconvenient, seems to give undue prominence to the operator. In the more recent and common form pH, the difference in type sufficiently marks the different duties of the two letters, but is opposite in direction to that conventionally used in other functional symbols, such as log *T* or d*t*. From this point of view, p*H* appears a more consistent form. There is, however, much to be said in favour of dropping the distinction in type between the two letters, and of regarding the quantity denoted by *pH* as an important independent variable without reference to its derived origin. Although the compound symbol may have a unique meaning, this is not necessarily true for its component letters; thus, *H* may denote a concentration and *p* a negative logarithm, or—sometimes more conveniently —*H* a dilution and *p* its logarithm. It is suggested that, in agreement with the accepted convention for single-letter symbols, all compound symbols in which *p* is used as an operator should be set in uniformly italicized type, as *pH*, *pK*, etc., without special advertisement of their derivations.

In chemical texts, the symbol *pH* (or its type variants) is commonly used as a noun, as in the phrase "The determination of *pH*", though for this purpose it is sometimes expanded to '*pH* value'. There is little to be said in favour of '*pH* value', which is longer, and no more descriptive, than *pH*. If the demand for brevity constrains us in the future to replace the noun 'time' by the symbol *t*, the inconsistency of '*t* value' will quickly become obvious. Much the most common plural form of the noun is '*pH* values' (or its type variants), a fact that probably reflects our uncertainty as to the correct plurals of the letters of the alphabet, and our resolve to mind our grammatical P values and Q values. The correct plurals of pH, p*H*, pH and *pH* are respectively pH's, p*H*s, pH's and *pH*s. The rule is simple. If there can be any doubt whether the final 's' is a plural ending or a part of the symbol proper, an apostrophe is required; but if a difference in type between the final letter of the symbol proper and the plural 's' avoids this ambiguity, no apostrophe should be used.

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Unshrinkable Wool

One of the more recent processes for making wool unshrinkable consists in synthesizing an organic polymer on the surface of the fibres[1], thus masking the surface-scale structure which is the primary cause of shrinkage. Precisely similar results may be obtained with inorganic polymers.

For example, when flannel is immersed in a solution of silicon tetrachloride in carbon tetrachloride, a vigorous reaction takes place between the adsorbed water of the wool and the silicon tetrachloride, a siliceous deposit being formed on the surface of the fibres. In consequence, the treated fabric shrinks very much less than untreated fabric during milling, as may be seen from the following data. These were obtained by treating 2·5 gm. patterns of flannel, previously conditioned at 65 per cent relative humidity and 22·2° C., with 100 c.c. of a solution of silicon tetrachloride in carbon tetrachloride for five minutes at 25° C. After treatment, each pattern was washed in two changes of 100 c.c. of carbon tetrachloride, followed by running water overnight, and the series of patterns was then milled by hand in 5 per cent soap solution.

Concentration of silicon tetrachloride (per cent by volume)	Percentage shrinkage in area during milling
0	28·9
2	18·9
5	6·2
7	3·6
10	2·6

A high degree of unshrinkability is readily obtained, and it is clear that polymerizable inorganic compounds are likely to find important practical applications in the wool textile industry.

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[1] Baldwin, Barr and Speakman, *B.P.* 567,501.